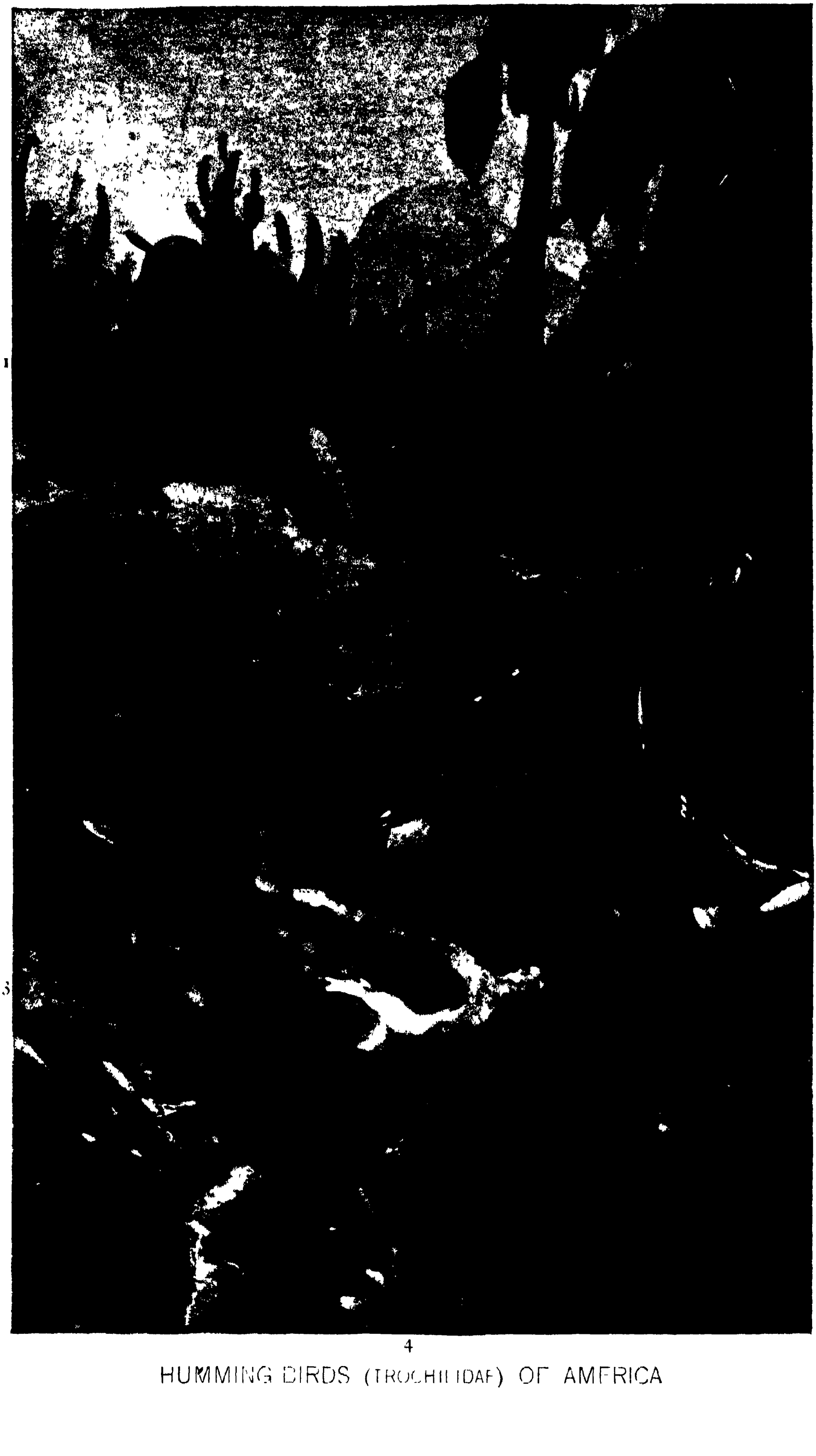
The Natural History of Animals



HUMMING BIRDS (TROCHILIDAE) OF AMERICA

HUMMING-BIRDS (*Trochilidæ*)

These brilliantly-coloured little forms, of which between 400 and 500 species have been described, are perhaps the most attractive members of their class, and some of them are the smallest known birds. Excluding the tail, which is often long out of all proportion, they vary in length from 8½ to rather less than 2½ inches. They are wholly American (and West Indian), ranging from Tierra del Fuego to Canada, and from sea-level to a vertical height of 16,000 feet. The mountains and hills of the northern parts of South America are inhabited by the largest number of beautiful species. Unfortunately, like many other birds of attractive plumage, they are ruthlessly hunted down to minister to the vanity of womankind.

The species represented in the plate are: 1. *Lamprolæma rhami*, 2. *Thalurania furcata*, 3. *Lesbia sparganura*, 4. *Calypte Helenæ*, 5. *Diphlogæna hesperus*.

The
Natural History of Animals

The Animal Life of the World in its various Aspects and Relations

BY

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CHAPTER LXVIII

ANIMAL FRIENDS—FISHES, MOLLUSCS, AND CRUSTACEANS AS FOOD—FISHERIES

To do anything like justice to the "harvest of the sea", not to mention the "freshwater harvest", would require a very considerable space, but the importance of the subject may be sufficiently illustrated for the purposes of this book by a few salient facts and figures. It will be convenient to successively consider Fishes, Molluscs, and Crustaceans, beginning in each case with a brief account of the more valuable species, and adding a few remarks on fisheries, culture-methods, &c. In the preparation of this chapter the writer has been greatly helped by Mr. J. T. Cunningham's *Marketable Marine Fishes*, as well as by papers and MS. notes by Professor J. Travis Jenkins.

Much kind assistance has also been given by the Secretaries to the French, German, Italian, Russian, and U.S. Embassies, the Legations of Holland and Scandinavia, the Italian Chamber of Commerce, the Imperial Russian Financial Agency, our own Department for Agriculture and Fisheries, and the Whitstable Oyster Fishery Company; also by the U.S.A. and Newfoundland Fisheries Departments, the High Commissioner for Canada, and the British Consuls-General in Christiania, Paris, and St. Petersburg.

FISHES (PISCES) AS FOOD

Without entering into minute technical details, it will be desirable in the first place to say a little about the three chief methods by which fishes are captured on a commercial scale, *i.e.* line-fishing, net-fishing, and trawling.

Line-Fishing. — Before the prehistoric races of Western Europe had learnt the use of metals there is evidence to show that large fishes, such as salmon, were secured by means of

bone harpoons, and the earliest fish-hooks were made of bone or shell. The remains from the Age of Bronze include a number of fish-hooks of that metal, and of these our modern devices of the same nature are doubtless lineal descendants. The most extensive development of line-fishing in this country is exemplified on the Scottish coasts, where such fishes as cod, haddock, and ling are thus caught. A series of cod-lines may reach the great length of eight miles, and carry 4680 hooks on attached "snoods", the favourite bait being whelks. The somewhat shorter haddock-lines are mostly baited with mussels or lug-worms.

Net-Fishing.—This more wholesale method of capture has the advantage of obviating the trouble and expense of bait. *Drift-nets* afford the chief means of catching fishes which, like herrings, pilchards, and mackerel, swim in large shoals at or near the surface, and they are nearly always worked at night. Such a net is practically a curtain, of which the upper edge is floated by corks, while the lower edge is sunk by weights. If by skilful manœuvring a shoal can be induced to dash against the meshwork, their heads easily pass through (the size of mesh being adapted to the particular species), and the projecting gill-covers prevent withdrawal. For herrings a series or "train" of drift-nets may extend a distance of 1¼ mile, while for mackerel the length may be twice as great. *Seines*, which may be as much as 1200 feet in length, are hanging nets which are drawn round shoals of fishes so as to enclose and secure them as in a bag. After the catch is made it may be hauled on to fishing-boats or drawn to shore according to circumstances. Certain other smaller nets will be mentioned as occasion arises.

Trawling.—This is, of course, a variety of net-fishing, and specially adapted for the wholesale capture of fishes that live on or near the bottom. The "trawl" or "beam-trawl" (fig. 1191) is essentially a large, flat, tapering net, which is dragged over the sea-floor, and may be as much as 100 feet long, with a mouth 50 feet wide. The "beam" is a horizontal spar by which the mouth is kept open, and which does not scrape along the bottom as sometimes supposed. It would be out of place here to describe all the elaborate details of construction. For most purposes trawling, especially as practised by steam-vessels, is rapidly superseding some of the older methods of fishing. And as it not only means the capture of vast quantities of

adult fishes, but also destruction of great numbers of immature individuals, trawling cannot but tend to deplete the natural supply. It is to be hoped that our knowledge will ultimately be sufficiently extensive and accurate to grapple with the question as to how best to regulate this kind of fishing, with a view to maintaining the more important species in sufficient numbers. At present our ignorance on many points is considerable, not to say profound, and there is no lack of exaggeration on a slender basis of fact.

THE HERRING FAMILY (CLUPEIDÆ).—The members of this family are widely distributed in the coastal waters of both tropical and temperate seas, but are not found in the deeper parts of the ocean. From the economic standpoint they are the most valuable of all food-fishes, which is partly due to the fact that they live in large surface-feeding shoals. The chief method of capture is by means of "drift-nets". The most important British fishes belonging to the family are Herring, Sprat, Pilchard, and Anchovy.

Fig. 1191.—Trawl-Net attached to Fishing-Boat

The Herring (*Clupea harengus*, fig. 1192).—Of all European marine fishes this contributes most largely to the human food-supply, especially when converted by curing methods into the familiar "red herring", "kipper", and "bloater". It was long supposed that herrings migrated periodically from northern waters to the south, on both sides of the North Atlantic, but their movements are now believed to be of much more local character. It may, in fact, be stated that the direction of these movements is alternately towards and from the land, the former being undertaken for the purpose of spawning in shallow water, where the heavy, sticky eggs sink to the bottom and adhere to various

objects. In British seas a distinction may, somewhat doubtfully, be drawn between "summer" and "winter" herrings, which appear to be two distinct varieties or races that spawn respectively at the seasons indicated. Winter herrings favour estuaries, and it is they which are fished, for example, in the Firth of Forth, Firth of Clyde, and Plymouth Sound. Summer herrings, on the other hand, avoid estuaries, and their spawning-grounds may be at some distance from the coast. They are the

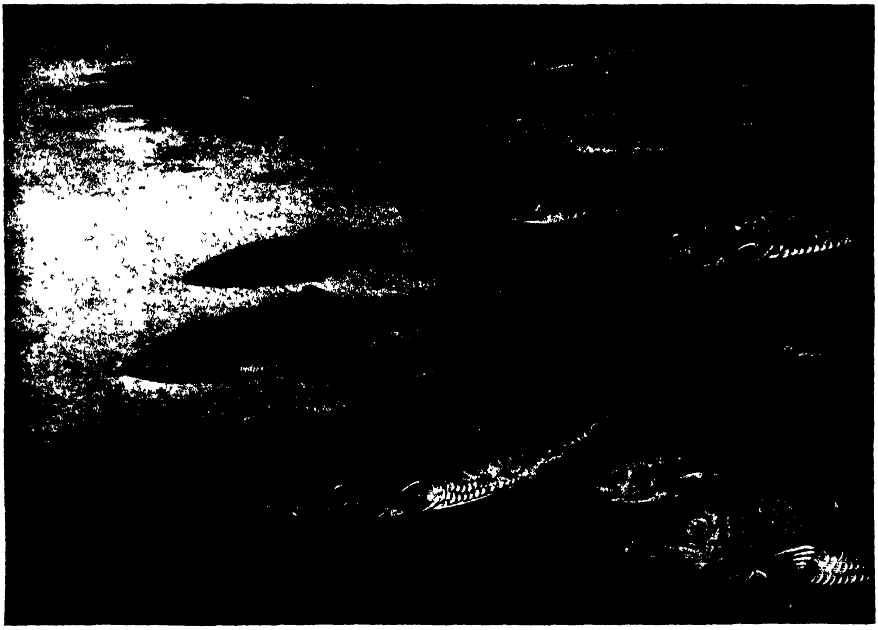

Fig. 1192.—Part of a Shoal of Herrings (*Clupea harengus*)

more important race, and are caught in vast numbers on the north-east coasts of Scotland and the east coast of England.

The Sprat, Pilchard, and Anchovy, which next fall to be considered, lay floating eggs, like the large majority of marine fishes.

The Sprat (*C. sprattus*).—This small species ranges from the north of Europe to the Mediterranean, and is largely fished from the coast of Kent round our south-east and south shores to Devonshire.

It appears that what is popularly known as "whitebait" is not a distinct kind of fish, but is chiefly made up of very young herrings and sprats, both of which are fond of making their way into sheltered estuaries.

The Pilchard (*C. pilchardus*).—This fish is pretty much like a herring in appearance, but its body is of rounder shape, the scales are very large, and there are several other points of difference. It ranges from the south of Ireland and England to Madeira, and into the Mediterranean. As is well known, the pilchard fishery of Cornwall is one of the most important industries of that county.

Sardines are simply young pilchards, and not a distinct species as sometimes supposed. They are fished on a large scale on the west of France, and also off the coast of North-west Spain (Galicia). Sardines are caught by the French to the value of some £400,000 per annum. Our own import of preserved fish (largely sardines) from France in 1902 was worth £373,960.

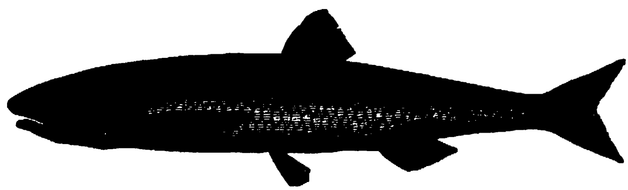

Fig. 1193.—Anchovy (*Engraulis encrasicholus*)

The Anchovy (*Engraulis encrasicholus*, fig. 1193).—This slender little fish, which is best known to us as the source of various flavourings, is easily distinguished from its congeners by the way in which its snout projects in front of the mouth, so that this opens on the under side of the head, much as in a shark. The anchovy ranges from the coast of Norway down the sea-board of Western Europe, and through the Mediterranean. Although native to our seas it is not the object of a British fishery, but the Dutch capture it in large numbers, in the Zuyder Zee and the estuary of the Scheldt, by means of small drift-nets fixed at either end, netted gaps between willow- and poplar-fences (near Bergen-op-Zoom), and by large sweep-nets. The importance of the anchovy-fishery to Holland will be realized from the fact that in 1902 the catch amounted to 100,000 ankers (an anker = about 88 lbs.). At Bergen-op-Zoom in that year 127 cwts. of these fishes were cured, over 77 cwts. of salt being used in the process. In the anchovy-fisheries along the Mediterranean littoral of Spain, France, and Italy drift-nets and seines are employed.

THE COD FAMILY (GADIDÆ).—From the economic stand-point

this family ranks second only to the one just considered. The fishes it includes are voracious ground-feeders characteristic of polar and temperate regions. With few exceptions they are marine, and their favourite habitat is in water under 200 fathoms in depth. Trawling and line-fishing are the chief methods by which they are captured. The most notable British species are Cod, Coal-Fish, Haddock, Whiting, Ling, and Hake. All of these lay floating eggs.

The Cod (*Gadus morrhua*, fig. 1194).—This large and important fish is the most valuable member of its family so far as its range extends, *i.e.* from Arctic seas to the Bay of Biscay on one side of the North Atlantic, and as far as

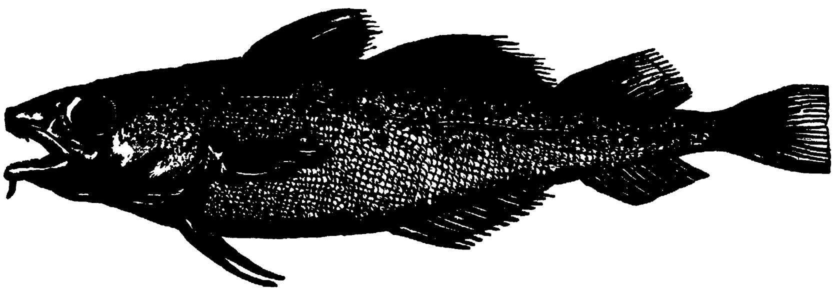

Fig. 1194.—Cod-Fish (*Gadus morrhua*)

New York on the other side. Günther thus summarizes some of the chief points regarding it (in *The Study of Fishes*):—"The Cod-Fish occurs between 50° and 75° lat. N. in great profusion, but is not found nearer the equator than 40° lat. Close to the coast it is met with singly all the year round, but towards the spawning-time it approaches the shore in numbers, which happens in January in England and not before May on the American coasts. The English resorted to the cod-fisheries of Iceland before the year 1415, but since the sixteenth century most vessels go to the banks of Newfoundland, and almost all the preserved cod consumed during Lent in the various Continental countries is imported from across the Atlantic. At one time the Newfoundland cod-fishery rivalled in importance the whale-fishery and the fur trade of North America." The Newfoundland catch for 1902 weighed about 140,000 tons.

The Coal-Fish (*Gadus virens*).—This fish, locally known as "green cod" and "saith", is somewhat smaller than the ordinary

cod, and ranges from the Arctic Ocean into the Mediterranean. It is largely fished in northern British waters, and is cured to a considerable extent.

The Haddock (*Gadus æglefinus*, fig. 1195).—Though of superior quality in the fresh condition, this fish is perhaps more familiar in the cured state, under the names of "yellow fish", "Finnan haddie", and so forth. In British seas average specimens are decidedly smaller than cod, and are easily recognizable by the blackness of the lateral line, and by the presence of a black blotch above the pectoral fin, attributed by tradition to

Fig. 1195.—Haddock (*Gadus æglefinus*)

the finger and thumb of the apostle Peter, though the John Dory is another candidate for the honour of the association. The range of the haddock is much the same as that of the cod, but it is only of marked importance in regard to the northern half of the British fishery area.

The Whiting (*G. merlangus*).—This comparatively small species is noted for delicacy of flavour, but to fully appreciate this it must be eaten immediately after capture, for it rapidly deteriorates, and stands carriage badly. Though ranging from Norway to the Mediterranean, and found all round our coasts, it is of more importance to the fisheries of the English Channel than to those farther north.

The Ling (*Molva vulgaris*).—This is a large and rapacious fish, which is largely cured, but is decidedly inferior to the

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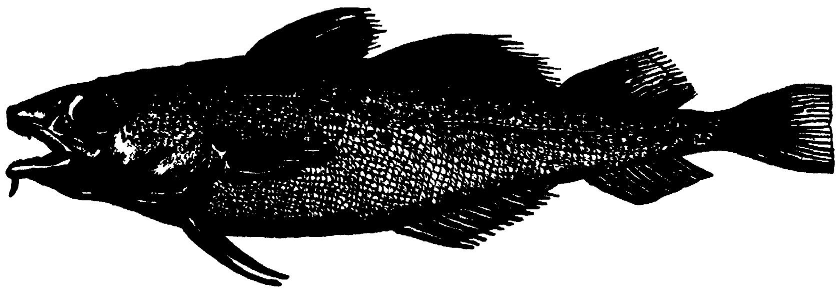

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haddock. It ranges from the Arctic Ocean as far as Gibraltar on the east of the North Atlantic, but only to Newfoundland on the west. It is mostly fished in the northern parts of the North Sea, and around the shores of the Orkneys, Shetlands, and Faroe Islands.

The Hake (*Merluccius vulgaris*).—Like the last-named species this is a rapacious fish of large size. Its range is similar to that of the cod, except that it is found throughout the Mediterranean, and is most abundant on the southern shores of Britain. Like most large forms it is somewhat coarse, and not greatly esteemed as food, though hake steaks are not to be despised.

THE FLAT-FISH FAMILY (PLEURONECTIDÆ).—These are carnivorous ground-fishes of great economic importance, especially in the north temperate region, and for delicacy of flavour some of the species are unrivalled. The valuable British forms which deserve notice are Turbot and Brill, with eyes on the left side; and Sole, Plaice, Flounder, Dab, and Lemon Dab, in which the eyes are on the right side. All these species lay buoyant eggs. Trawling is by far the most important method of capture, after which comes line-fishing.

The Turbot (*Rhombus maximus*).—This is the most esteemed of the larger flat-fishes, and may attain a weight of over 20 lbs. It is a shallow-water form, and ranges from the Black Sea, through the Mediterranean, up the eastern coast of the North Atlantic as far as Denmark and South Scotland. Bony tubercles are imbedded in the skin of the left side. In accordance with the fact that the turbot is highly predaceous, feeding upon other fishes, its mouth is larger than in most members of the family.

The Brill (*R. lævis*).—Except in its smaller size, and the absence of tubercles on the skin, this species resembles the turbot in appearance, mode of feeding, and distribution.

The other flat-fishes to be noticed here all have the eyes on the right side of the body and (except the Halibut) have small mouths, adapted to feeding on worms and other small creatures.

The Halibut (*Hippoglossus vulgaris*).—This is the largest of all flat-fishes, and is said to sometimes reach the length of 20 feet, while individuals of 6 or 7 feet long are often caught in British seas. A 7-foot halibut weighs somewhere about 300 pounds or rather more. It is a decidedly northern species, and appears to range right round the southern shores of the Arctic

Ocean. In the Atlantic its area of distribution extends as far south as the English Channel. The halibut feeds on fishes and crustaceans.

The Sole (*Solea vulgaris*, fig. 1196).—This valuable and delicately-flavoured food-fish, adult specimens of which average from 12 to 18 inches in length, is distinguished from many other forms by its shape, which is a narrow oval with continuous outline, free from sharp curves or projections. It ranges from the Mediterranean to the south of Scotland, and is captured for the most part in water under 30 fathoms deep.

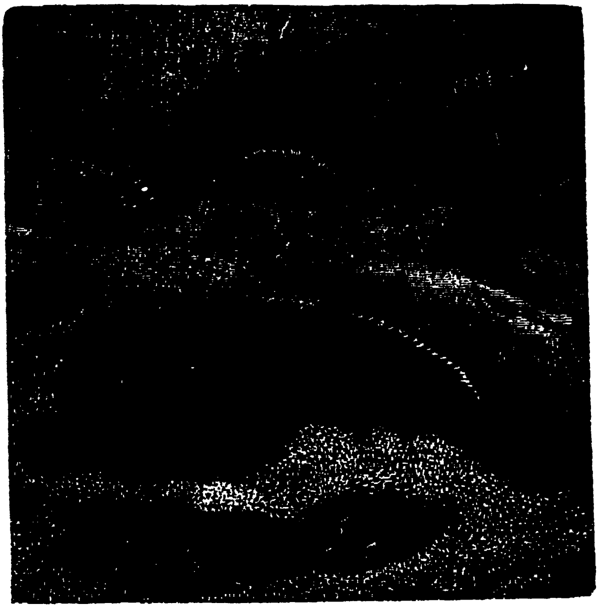


Fig. 1196.—Soles (*Solea vulgaris*)

The Plaice (*Pleuronectes platessa*).—This common British species is of considerable economic importance, though its flesh is rather flavourless. Average specimens vary from 15 to 18 inches in length, but a larger size is often reached, especially in northern waters. The plaice may easily be recognized by the large orange-coloured or rust-red blotches on the dark side of the body. It ranges from the north coast of Europe as far south as the Bay of Biscay.

The Flounder (*P. flesus*).—This is a rather small species, the pigmented side of which is dark-brown or black. It ranges along the entire west coast of Europe, and is also found in the Baltic and Mediterranean. Flounders are estuarine fishes, and are able to live in fresh water.

The Dab (*P. limanda*).—This is about the same size as the flounder, but its pigmented side is of light-brown colour, with darker spots, and the skin is rough. It ranges from the north of Europe to the Bay of Biscay, and is found both in estuaries and the open sea.

The Lemon Dab (*P. microcephalus*).—This is often sold under the name of Lemon "Sole", but it is a poor substitute for the true Sole, which it resembles in shape though not in colour. The dark side of the body is of a yellowish-brown, marked with numerous spots. The range is practically the same as that of the Dab, but it is most abundant in fairly deep water.

THE MACKEREL FAMILY (SCOMBERIDÆ).—The members of this family are highly predaceous tropical and temperate fishes which swim in shoals in the open sea, but approach the land in pursuit of prey. Their form admirably adapts them to swift progression (see vol. iii, p. 41). It will be necessary here to consider two

Fig. 1197.—Mackerel (*Scomber vernalis*)

species, the Mackerel and Common Tunny, both of which lay floating eggs.

The Mackerel (*Scomber vernalis*, fig. 1197).—This is one of the most beautiful of our native marine fishes, and adults vary in length from about 1 foot to 17 inches. The range is from the Mediterranean to the Canaries, and north along the shores of Europe to the south of Norway. So far as British fisheries are concerned mackerel are of importance from the coast of Norfolk round the Straits of Dover to Devon and Cornwall. Drift-nets and seines are the chief means of capture, but lines are also employed, especially in the south-west of England.

The Common Tunny (*Orcynus thynnus*).—This can be described as a gigantic mackerel, which may reach a length of 10 feet, and a weight of about half a ton. Although sometimes taken in the North Sea and Baltic it is essentially a native of the Mediterranean, where it has been the object of an important

fishery from very early times. Its flesh is eaten both when fresh and in the preserved condition. Pickled Tunny (*Saltamentum Sardicum*) was considered a delicacy by the ancient Romans. The Italian tunny-fishery, of which Sardinia and Sicily are the chief centres, is a considerable industry, which yielded over £111,000 in 1902. It commences in spring, when the fish approach the shore to spawn, and the shoals are either driven into shallow water and surrounded by a series of strong nets, or else chased into a sort of net-labyrinth, in the innermost compartment of which they are slaughtered with clubs, boat-hooks, and the like.

Fig. 1198.—Striped Red Mullet (*Mullus surmulletus*)

THE RED MULLET FAMILY (MULLIDÆ).—The members of this family are mostly tropical fishes, but one species, the Striped Red Mullet (*Mullus surmulletus*, fig. 1198), is common in the Mediterranean, from which it ranges to the Canaries and Norway. It is taken in some numbers off the south and south-west shores of England by means of small drift-nets known as trammels. Average specimens weigh about half a pound. It is a particularly handsome fish, of bright-red colour (except below), with several narrow yellow bands along its sides. There is also a Plain Red Mullet (*M. barbatus*), without the stripes, which is common in the Mediterranean, and is occasionally taken in British waters. Most probably it is a distinct species.

The Red Mullet is universally regarded as a delicacy, and its flavour has suggested the popular name of "sea woodcock". The epicures of ancient Rome were extravagantly fond of it. On this

point Günther remarks (in *The Study of Fishes*): "The Romans prized it above any other fish; they sought for large specimens far and wide, and paid ruinous prices for them. . . . Then, as nowadays, it was considered essential for the enjoyment of this delicacy that the fish should exhibit the red colour of its integuments. The Romans brought it, for that purpose, living into the banqueting-room, and allowed it to die in the hands of the guests, the red colour appearing in all its brilliancy during the death struggle of the fish. The fishermen of our times attain the same object by scaling the fish immediately after its capture, thus causing a permanent contraction of the chromatophores containing the red pigment."


Fig. 1199.—John Dory (*Zeus faber*)

THE JOHN DORY FAMILY (CYTTIDÆ).—The members of this family inhabit temperate seas, and, so far as known, lay floating eggs. The body is greatly flattened from side to side. Other fishes constitute the food. Only one, species requires notice, *i.e.* the *John Dory* (*Zeus faber*, fig. 1199), which may be of considerable size (up to 18 lbs. in weight). Its narrow body is very deep, while the elongated first dorsal fin and large staring eye give it an extraordinary appearance. The colour is greenish-brown, banded with yellow, and on either side of the body there is a large round black patch with a yellow border. Günther says (in *The Study of Fishes*):—"The fishermen of Roman Catholic countries hold this fish in special respect, as they recognize in a black round spot on its side the mark left by the thumb of St. Peter when he took the piece of money from its mouth". (See also p. 267.) The John Dory ranges from the Mediterranean to Madeira and Norway. It is trawled in considerable numbers in the English and Bristol Channels.

THE GURNARD FAMILY (COTTIDÆ).—Here are included widely

distributed ground-fishes, living in shallow water. Among them are the little *Bull-Heads* (*Cottus*), some of which are common on our coasts, while one, the Miller's Thumb, is a familiar inhabitant of our brooks. They are of no economic importance, though the Germans make soup of the last-named form. The larger Gurnards, however, are valuable food-fishes, of which several are British. They lay floating eggs. The head is large and covered with strong plates, while some of the rays of the pectoral fins are free and serve as feelers. The commonest native species are the *Grey Gurnard* (*Trigla gurnardus*) and the *Red Gurnard*

Fig. 1200.—Thin-lipped Grey Mullet (*Mugil capito*)

(*T. cuculus*), both of which range from the Mediterranean to Norway. The latter is most abundant in the English Channel, and the former in the North Sea.

THE GREY MULLET FAMILY (MUGILIDÆ).—Grey Mullets are handsome forms common on temperate and tropical coasts. They frequent inlets and estuaries, where they feed on vegetable food. There appear to be two species, the *Thin-lipped* and *Thick-lipped Grey Mullets* (*Mugil capito*, fig. 1200, and *M. chelo*), which range from the Mediterranean into British seas. Both are silver-grey in colour with longitudinal black streaks, and distinguishable from each other by the nature of the lips as indicated in their names. They are taken in large numbers by seines and other nets on the south coast of England, but the thick-lipped species seems to be more common off the western part of this area.

So far we have considered marine food-fishes, and it will be

now appropriate to make some reference to the members of the Eel and Salmon families, which, in a sense, link together the forms of sea and fresh water.

The Eel Family (Murænidæ).—Eels are more or less cylindrical fishes, which may either be scaleless or possess minute scales sunk in the skin. They are widely distributed through the fresh waters and seas of the tropical and temperate regions, some of the most specialized kinds inhabiting the abysmal parts of the ocean. They are captured either by hook and line or by means of wicker-work (or metal) traps, provided with funnel-shaped openings. Trident-shaped eel-spears, with numerous tines, are also used in some localities. Creatures of the kind have been esteemed as a savoury food from very remote times, the ancient Greeks and Romans, for example, being extremely partial to them. There are two British species, the Conger and the Common Eel.

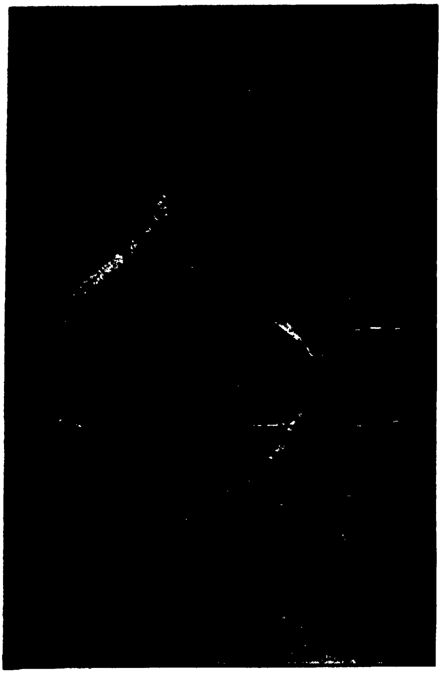


Fig. 1201.—Conger Eels (*Conger vulgaris*)

The Conger (*Conger vulgaris*, fig. 1201).—This is a large, scaleless marine eel, which not uncommonly attains the length of 6 or 7 feet and a weight of 60 lbs. It is a shallow-water form, and has a very wide distribution, occurring all round the shores of Europe, and also inhabiting the coastal waters of St. Helena, Japan, and Tasmania.

The Common Eel (*Anguilla vulgaris*).—This is a good deal smaller than the Conger, but full-grown specimens attain a length of 3 feet. When adult it inhabits fresh water, but repairs to the deep sea to spawn, the young eels or elvers making their way up rivers after undergoing a rather startling kind of transformation (see vol. iii, p. 433). This species has a wide distribution in the river-systems that discharge their waters into the North Atlantic (west as well as east coast) and Mediterranean.

THE SALMON FAMILY (SALMONIDÆ).—Salmonoid fishes are both commercially important and also of interest from the sporting point of view. About the middle of the back there is a dorsal fin of the usual character, and some distance behind this a small fatty or adipose second dorsal, unsupported by fin-rays. The nature of this second fin is a distinctive character. The family includes various species of Salmon, Trout, Charr, Grayling, and Smelt. All are natives to the non-tropical parts of the Northern Hemisphere, with the exception of a kind of Smelt (*Retropinna Richardsoni*) found in New Zealand and the Chatham Islands.

Fig. 1202.—River Trout (*Salmo fario*)

Some of the salmonoids are purely marine, others never leave fresh water, and others again may be described as marine forms which ascend rivers to spawn. The eggs are heavy and adhesive. Only a few important species require mention here.

The Salmon (*Salmo salar*).—This universally esteemed fish spawns in the rivers of temperate Europe as far south as 43° N. lat., and those of temperate North America down to 41° N. lat. In Britain it reaches commonly a weight of 20 to 40 lbs., and much larger specimens have been recorded. Salmon are eaten not only when fresh, but also, especially in North Europe, in the smoked condition. The chief method of capture is by netting at the time when the fish are ascending rivers, but large numbers are also taken with the rod.

The River Trout (*Salmo fario*, fig. 1202).—Average adult specimens of this well-known angler's fish attain the weight of

about 1½ lb., but this may be greatly exceeded, especially in the case of local races. It is a purely freshwater species, and more delicate in flavour than is usual with such forms.

The Smelt or *Sparling* (*Osmerus eperlanus*, fig. 1203).—This rather small fish is generally considered a dainty. It abounds in the tidal parts of many of the rivers of Europe and North America, ascending these for some distance for the purpose of spawning. Günther says of it (in *The Study of Fishes*):—"In the sea it grows to a length of 8 inches, but, singularly, it frequently

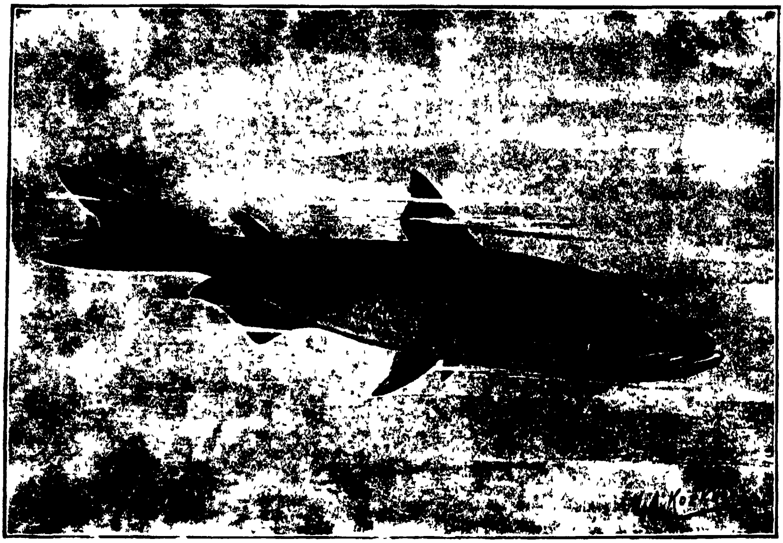


Fig. 1203.—Smelt (*Osmerus eperlanus*)

migrates from the sea into rivers and lakes, where its growth is very much retarded. That this habit is one of very old date is evident from the fact that this small freshwater form occurs and is fully acclimatized in lakes which have now no open communication with the sea." Smelts are taken in large numbers by seines in some of the English estuaries which open into the southern part of the North Sea.

There are several other families of ordinary bony fishes (Teleostei) of which the freshwater species are used as food, such as the Carp Family, Pike Family, &c. As, in this country at any rate, they are of no particular economic importance, it is scarcely necessary to deal with them here. A few words, however, about a few of the families of lower fishes will not be out of place.

Those of most note include Sturgeons, Skates and Rays, and Lampreys.

THE STURGEON FAMILY (ACIPENSERIDÆ).—This belongs to an ancient group of Fishes (Ganoidei), closely related to the ordinary bony type. There are about twenty species of Sturgeon, all inhabiting the temperate part of the Northern Hemisphere. Like Salmon, they ascend rivers to spawn, and also in some cases for wintering, and some of them are altogether confined to the waters of the land. The Common Sturgeon (*Acipenser sturio*, fig. 1204) belongs to the British fauna, for it enters some of our rivers, as

Fig. 1204.—Common Sturgeon (*Acipenser sturio*)

the Severn and Thames, and, being the property of the Crown, is known as a "royal" fish. Though perhaps 6 feet may be taken as the length of an average adult, a much larger size—up to about 12 feet—may be attained. The species is found on both sides of the Atlantic, on the one side entering the rivers of the Eastern United States, and on the other those of West Europe and the Mediterranean. It is absent from the Black Sea. The much smaller but more esteemed Sterlet (*A. ruthenus*) is native to the rivers that debouch into the Black and Caspian Seas, and also inhabits the Siberian rivers. It does not, as a rule, descend into salt water. The Giant Sturgeon or Hausen (*A. huso*), on the other hand, is much larger than the common species, but somewhat coarse. It lives in the Black Sea, Sea of Azov, Caspian, and the corresponding river basins. Güldenstädt's Sturgeon (*A. Güldenstädti*) ascends the rivers of the Black Sea.

So far as Europe is concerned, the sturgeon-fishery is of most

importance to Russia. The flesh of all the species is used as food, the hard roes (ovaries) are cleaned and salted to figure as caviare, to the extent of some 10,000 tons annually, and isinglass is prepared from the swim-bladders. For all these purposes the smaller sorts of Sturgeon, especially the Sterlet, are most esteemed. The Volga fishery is on the largest scale, and goes on at two seasons, autumn and winter. During the former, ground-lines with numerous hooks are used, and operations cease when the river begins to freeze. With increasing cold the fishes congregate at certain spots for hibernation, and such places are carefully marked by the fishermen. Later on, in January, when the cold is at its maximum, the winter-fishing is ushered in with great festivities. Good-sized holes are broken through the ice at the spots previously noted; the fishes, disturbed by the noise, come to the surface, and are promptly secured by means of harpoons and iron hooks.

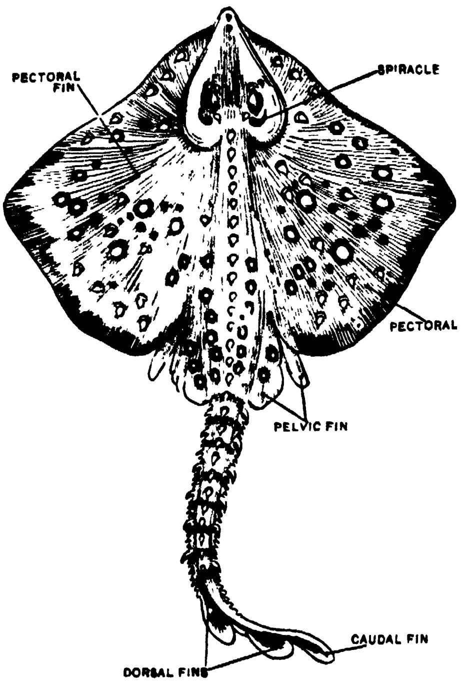


Fig. 1205.—Thornback (*Raia clavata*)

Skates and Rays (Batoidei).—These flattened, narrow-tailed, rhomboidal forms constitute, with Sharks, Dog-fishes, &c., the great group of cartilaginous fishes (Elasmobranchii). The two most important British species are the comparatively smooth-skinned Skate (*Raia batis*) and the Thornback (*R. clavata*, fig. 1205), of which latter the characters are sufficiently indicated by the name. The Skate may attain a length of 6 feet or more, and the Thornback about half as much. Both are common in British waters, where they are captured by trawling and by line-fishing. Though not among the choicer food-fishes, they are largely eaten, the enormous pectoral fins, cut into strips and rolled, constituting what is commonly known as "crimped skate".

Round Mouths (Cyclostomata).—The eel-shaped scaleless

Lampreys, which can be only called fishes by courtesy (see vol. i, p. 291), are considered great delicacies in some Continental countries, but are not abundant enough in Britain to be of economic importance. The best-known of our three native species are the Sea Lamprey (*Petromyzon marinus*), which may grow to the length of 3 feet, and the much smaller River Lamprey or Lampern (*P. fluviatilis*), less than half that size, both of which are marine forms that ascend some of our rivers to spawn, the Severn

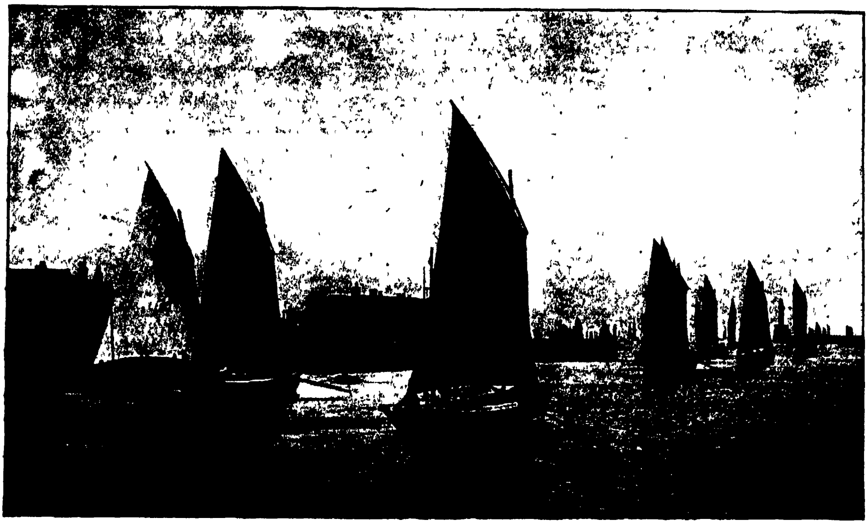


Fig. 1206.—Herring-Boats leaving Aberdeen Harbour

being especially notable in this respect. In *Cassell's Dictionary of Cookery* the following remarks are made about the lamprey, apparently the large species:—"This not very wholesome, but rare and rich fish, was a great favourite in ancient times, and is well known to the student of English history, as it was an attack of indigestion, brought on by eating of it too freely, which caused the death of Henry I. . . . Probable cost uncertain, lampreys being seldom offered for sale."

FISHERIES

In practical fishery matters a distinction is drawn between "wet" fish, *i.e.* fishes proper, and "shell"-fish, among which both molluscs and crustaceans are included. We are here for the present concerned with the former only (except as regards some of

the statistics). The importance of the matter to this country may be realized by giving a few figures.

In 1901 the number of fishing-boats registered in the United Kingdom (including the Isle of Man and Channel Islands) was as follows:—First class (15 tons or more), 7083; second class, 14,067; third class, 4647; total tonnage, 302,188. And to this must be added a large number of unregistered boats, chiefly of the third class. During the same year 68,878 persons were regularly employed in fishing, and 37,599 more found occasional employment.

The amount and value of the British catch for 1902 were as follows:—

Wet Fish.		
	Quantity in Cwts.	Value.
		£
Soles	76,624	512,596
Turbot ...	64,094	245,215
Other prime fish	33,184	81,550
Cod	1,584,528	865,934
Haddock ...	2,941,264	1,787,942
Herrings ...	8,437,566	2,531,912
Ling	252,627	115,925
Mackerel ...	599,983	390,321
Sprats	76,066	16,636
Whiting ...	403,247	161,392
Other fish ...	3,432,862	2,586,675
	17,902,045	9,296,098

Shell-Fish.		
	Number.	Value.
		£
Crabs ...	8,680,645	79,968
Lobsters	1,632,110	73,317
Oysters ...	43,482,711	119,086
Other shell-fish	cwts. 613,436	138,544
		410,915

Total Value of British Catch for 1902,

£9,707,018.

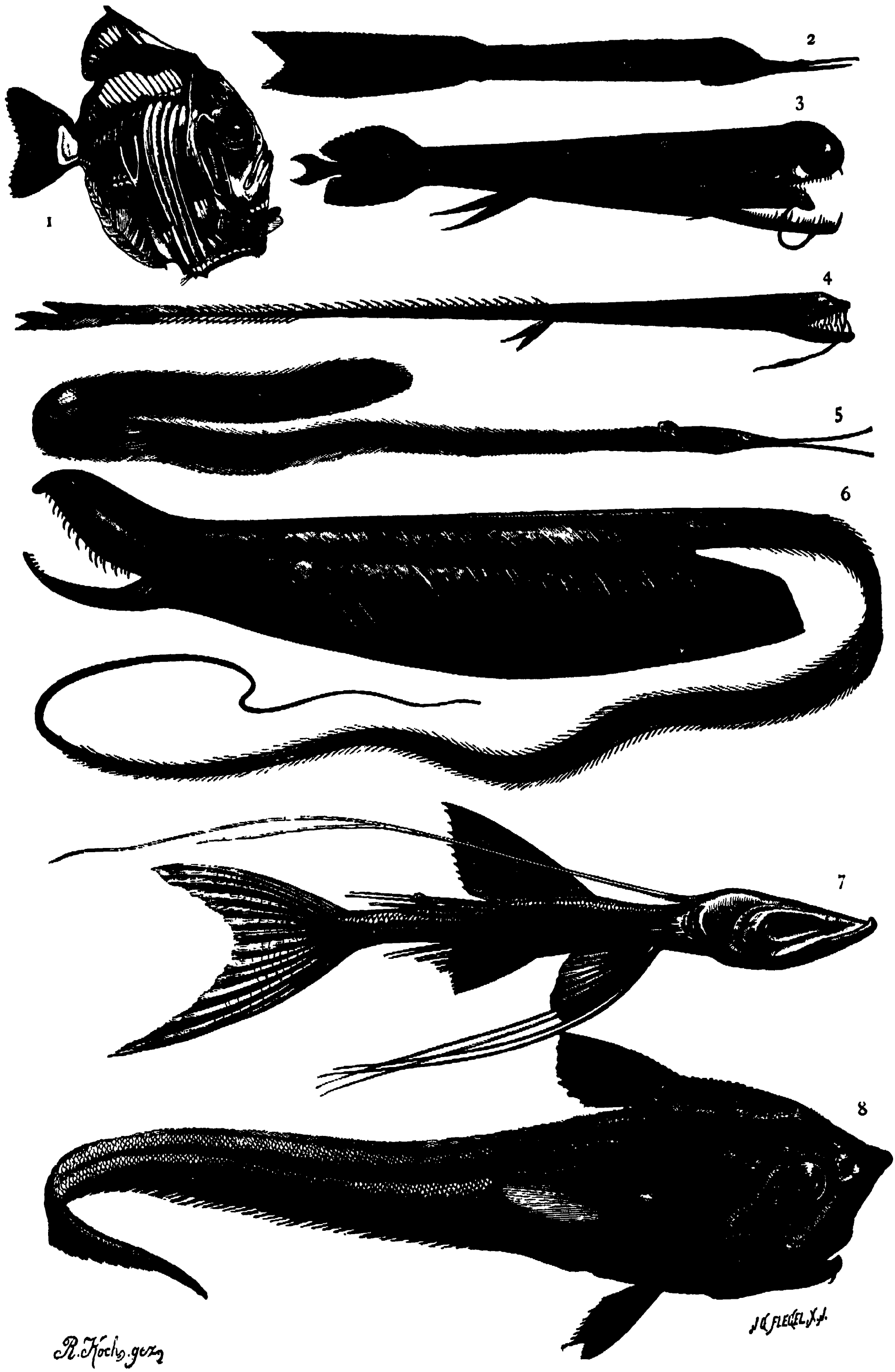
We do not entirely rely upon the British fishing industry for supplies, for in 1902 our imports of fresh and cured fish amounted to 2,587,370 cwts., valued at £4,105,800. Of this amount, however, 439,773 cwts. (worth £809,322) were re-exported, while we exported a part of our own catch to the value of £3,706,002, which included 2,249,976 barrels of herrings, worth £2,933,864. Of the exported herrings no less than 1,364.613 barrels were cured in Scotland, and the greater part of these were for Russian consumption, some of them finding their way as far east as Vladivostock.

During the last few decades it has gradually been realized by maritime nations that the supply of fish is not inexhaustible, and

DEEP-SEA FISHES (drawn to various scales)

The fishes of the deep sea are highly carnivorous forms, often provided with formidable teeth. The eyes are either very large or else greatly reduced. Luminous organs are often present. Many of these fishes are of bizarre appearance, as may be gathered from the plate, which represents eight species, as follows:—

1. *Sternoptyx diaphana*: small and translucent, with rounded luminous organs on the sides of head, body, and tail.
2. *Cyema atrum*: a small deep-sea eel, with reduced eyes.
3. *Malacosteus Indicus*: very large eyes, two luminous organs on the side of the head, and enormous mouth.
4. *Idiacanthus ferox*: a greatly attenuated form, with numerous small rounded luminous organs on the side of the body.
5. *Nemichthys ingens*: a greatly elongated deep-sea eel, with large eyes, and jaws drawn out into a slender beak.
6. *Saccopharynx ampullaceus*: a large deep-sea conger-eel, which has succeeded in swallowing a fish much bigger than itself.
7. *Bathypterois longicauda*: a deep-sea fish with reduced eyes, and much elongated fin-rays serving as feelers.
8. *Macrurus crassiceps*: a species of a widely distributed deep-sea family related to that including the cod, &c. Eyes extremely large, and mouth on the under side of the head.



DEEP-SEA FISHES

DRAWN TO VARIOUS SCALES

this is partly due to the steady increase of steam-trawling, which means capture on a wholesale scale. Practical men are recognizing more and more that expert scientific advice must be requisitioned if the supply of fish is to be maintained, and still more so if it is to be increased. As Cunningham very justly remarks (in *Marketable Marine Fishes*):—"It can scarcely be expected that the fisherman or fish merchant will spend his short and hard-earned leisure moments in the study of the blue-books and technical memoirs in which the results of research are described; and when certain newly-established facts are brought before them in other ways it frequently happens that they either deny these facts, as contrary to their own experience, or turn a deaf ear, from the conviction that such matters are of no practical importance. With reference to the contradiction of the naturalist's conclusions, it may be urged that, although he may not be able to climb the rigging of a smack, and is generally sick while at sea, although also he may be as ignorant as a baby of the mysterious and complicated practice of the fish-trade, still he has two advantages over the professional fish-man in attempting to get at the truth concerning the life and habits of fish. Firstly, he has been trained to appreciate the value of scientific evidence, and is on his guard against jumping at conclusions; secondly, he can use instruments of precision, which are as essential to the investigation of some of the matters in question as the compass and the lead to the handling of a fishing-vessel. With regard to the practical importance of the naturalist's researches and results to the fishing industry, it can only be said that there is no doubt about it. It is an undeniable fact that parliamentary legislation and local by-laws are at the present time constantly being demanded or proposed for the benefit of the fisheries, and the reasons by which these proposals and demands are supported consist largely of statements concerning the natural history of the fishes and other marine creatures concerned. It is necessary, therefore, that we should be able to test the correctness of these statements, and should be able to judge correctly of the most probable effect of the measures proposed on the productiveness of the fisheries."

A few epoch-making dates in fishery work may here be appended with advantage, and the reader may draw his own conclusions as to the relative enterprise displayed by the nations concerned. 1862, Professor Allman of Edinburgh investigated

the spawning of herrings at the request of the Scottish Fishery Board. 1864, Professor Sars of Christiania commissioned by the Norwegian Government to investigate the natural history of the cod and the cod-fisheries of the Lofot Islands. 1870, the Prussian Minister of Agriculture instituted a Commission for the Investigation of the German Seas. 1871, institution of the United States Commission of Fish and Fisheries. 1882, establishment of the new Fishery Board for Scotland; this marked the first commencement, on a large scale, of the application of scientific methods to British fishery problems. 1884, inauguration of the Marine Biological Association of the United Kingdom (active work at the Plymouth Marine Station commenced in 1887) on the initiative of Professor Ray Lankester. The late Professor Huxley was the first president. In the same year the marine laboratories at St. Andrews and Granton (near Edinburgh) were completed. 1886, a Fishery Department of the Board of Trade was organized, but without power to make scientific investigations. 1899, an annual sum of £10,000 was devoted to Irish Sea-Fisheries. More recently the countries interested in the fisheries of the North Sea have agreed to jointly investigate that area with regard to fishery problems on scientific lines. In 1901 the Board of Trade appointed a Committee on Ichthyological Research, with the view of ascertaining the best methods of carrying out scientific investigations of problems affecting British fisheries. The committee presented their report in the following year, suggesting greatly increased expenditure, with a view to solving certain pressing problems, and recommending, among other things, the establishment of a Fishery Council for England.

Some varieties of fishery work which are of special importance may now be very briefly indicated.

Statistics.—Until we know with some approach to definiteness the amount of each kind of fish captured yearly, together with the time, place, and method of capture, it will be impossible to form a sound opinion as to whether the natural supply is actually diminishing generally or locally.

Habits and Life-Histories of Food-Fishes.—It is clear that full knowledge on these points is absolutely necessary from the practical stand-point, for upon such knowledge must ultimately depend the various means adopted for regulating the fishing industry. Full information of the sort regarding any particular form, joined

to that derived from statistics, would enable us to determine with a reasonable approach to accuracy the best methods, times, and places for capturing such fish, securing on the one hand a profitable result, and on the other hand obviating wasteful depletion of the natural supply.

Food of Fishes.—Directly or indirectly the most important source of fish food is found in "plankton", *i.e.* the various floating organisms which are found in vast numbers at or near the surface of the sea (and of lakes). Minute plants, animalcules, small crustaceans (especially Copepods), various larvæ, and floating eggs (including those of fishes themselves) are among the more important constituents. Some valuable food-fishes, such as the herring, feed solely on plankton.

The amount of this food available bears a direct relation to the fish-supply, and Professor Hensen of Kiel has devised ingenious and elaborate methods of estimating it in a quantitative manner. Details cannot be given here, but the following extracts from a paper by J. Travis Jenkins (*The Methods and Results of German Plankton Investigations*) will serve to give some idea of the importance of the matter:—"The plankton estimation methods of the Germans, the credit for initiation of which is due to Hensen, differ from and mark an advance upon the methods hitherto employed in England, inasmuch as no attempt is made in the latter country to arrive at a quantitative as distinguished from a qualitative result. The questions that Hensen attempts to answer are—(1) What does the sea contain at a given time in the shape of living organisms in the plankton? and (2) How does this material vary from season to season and from year to year? It may be pointed out that the results obtained by the German investigators are largely due to the liberal attitude taken by their Government with regard to subsidizing scientific investigation of problems connected with the sea-fisheries. It is to be hoped that the Irish Sea may be subsequently investigated in like manner. A comparison with the results already obtained for the North and Baltic Seas could not fail to be of interest and to yield important results." Some of the most striking estimations were made on the number of Fork-footed Crustaceans (Copepoda) in plankton, since it is these which constitute the chief food of herrings, sprats, and their allies. The following results were yielded by the method:—"For a square mile of surface-water the annual consumption of Cope-

poda can be regarded as approximately 975 billion, or for the 16 square miles of the Eckenförde fishery district [in the West Baltic] a grand total of 15,600 billion. A billion Copepoda yield not less than 1500 kilograms of dry organic substance, so that the 15,600 billion weigh not less than 23,400,000 kilograms [*i.e.* more than 22,982 tons]. Taking the average weight of an adult West Baltic herring as being 60 grams, and allowing that every herring uses in fifty days its own weight of organic substance, we find that every herring consumes annually 438 grams. In the 16 square miles of the Eckenförde fishery district there exists food in the shape of Copepoda for 534,000,000 herring of an average body weight of 60 grams. This result may, of course, be largely problematical, but it is at any rate extremely interesting. The North Sea, in a similar manner to the Baltic, contains an abundant wealth of Copepoda. The open ocean, on the other hand, contains much less." The number of floating fish-eggs of a particular kind contained in plankton may be used as a basis for determining the number of fish of the sort present in a given area at a given time. Applying this method to the cod and plaice of the Eckenförde, Hensen estimates that "man captures for his own use every year about one-fourth of the total number of adult fish in this particular area of the West Baltic. This result is surprising to those who consider the resources of the sea as inexhaustible, and believe that the number of fish caught by man bears only a small proportion to the number actually present in the sea." It is also interesting to learn that the northern seas are richer in plankton than those in warmer latitudes. The possibilities of the Hensen methods are thus seen to be very considerable, but it is unsafe to generalize from a small number of determinations, for the distribution of plankton in a given area is by no means uniform. In this, and many other matters involving accurate scientific research, large government subsidies are urgently needed in this country. We are co-operating, it is true, with other nations in a scientific survey of the North Sea for the space of three years, but during that period the annual grant of £2000 per annum to the Scottish Fishery Board is suspended, thus seriously crippling an organization that has long been engaged in work of the most valuable kind.

Fish-Culture (Pisciculture).—The rearing of fishes in ponds is a very ancient art, which was practised by the Egyptians,

Greeks, and Romans, of antiquity. The young of various species were made to enter lagoons, prevented from again escaping, and kept till large enough for the table. Culture in freshwater ponds has been an important Chinese industry from time immemorial, and was well understood in England during the Middle Ages, especially by the monks, who did not care to rely on chance for the periodic fish repasts prescribed by the Church. Remains of old "fish-stews", in which carp, eels, &c., were reared, abound in this country.

A very interesting outcome of the fish-culture of the old Romans still exists in the lagoon of Comacchio, at the mouth of

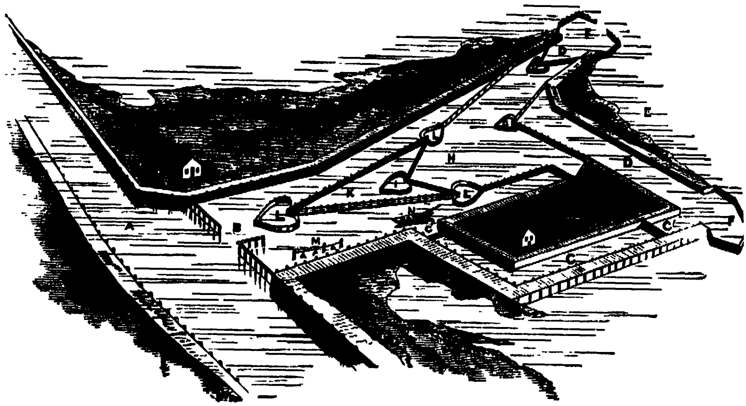


Fig. 1207.—A Division of Comacchio

A, Canal Palotta. B, Entrance from canal. C, Canal for boats. C', Sluices. D, First compartment of labyrinth. E, Outer basin. F, Antechamber of first compartment. G, Chamber of ditto. H, Second compartment. I, Chamber of ditto. K, Third compartment. L, L, L, Chambers of ditto. M, Wicker-work baskets for keeping fish alive. N, Boat and tackle. O, Dwelling-house. P, Storehouse.

the Po, where eels are grown on a large scale, and distributed throughout Italy both fresh and in a preserved condition. The definite records of the industry date from 1229, and so long ago as the end of the sixteenth century the annual revenue derived from the culture amounted to £16,000 annually, a sum which, of course, represented much more at that time than it does now. The eels sold in 1903 fetched over £28,000. The whole lagoon, which is bounded at the sides by the Reno and Volano mouth of the Po, is a perfect labyrinth of ponds and canals, of which a faint idea may be gained by examining fig. 1207. The conduct of this industry is a very elaborate matter. The ascending swarms of elvers have to be guided to their destination, the supply of fish-food maintained, full-grown eels captured (from August to December), and the catch prepared for the market.

The pond-culture of Carp is carried on in a very systematic manner in some parts of Germany, and it need only be said that the fish are transferred from one pond to another according to age.

The discovery of the possibility of artificial fecundation, by mixing eggs and milt together, constituted an epoch in fish-culture which opened up far-reaching possibilities the importance of which has only been fully realized of late years. It appears to have been first practised, for salmon and trout, by S. L. Jacobi of Hohenhausen, in Westphalia, so long ago as 1748, and was continued by him and his sons, with profitable results, till 1825. George III (of England) gave a pension to Jacobi in 1771.

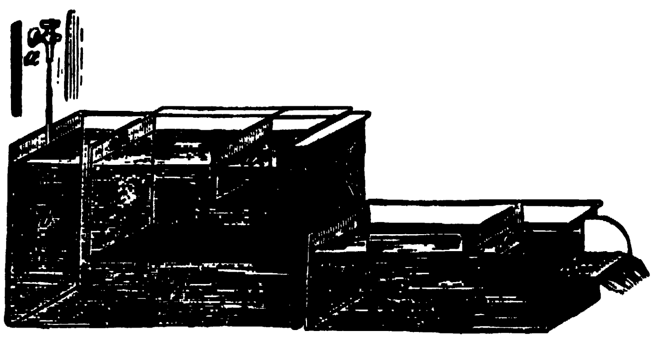


Fig. 1208.—Staby's Californian Trough

A, Hatching tank, into the outer part of which (*b*) water flows from a tap (*a*); *c* and *d* are hatching trays with floors of fine wire-gauze: *e*, outflow. *B*, Tank to catch fry which escape from *A* when *d* is removed; they pass into the space *f*, but are prevented by the gauze partition *g* from getting washed away in the outflow to the right.

Scotland, as usual, was one of the first of other countries to profit by an improvement on old methods, for we find that in 1837 John Shaw, a gamekeeper at Drumlanrig of the Duke of Buccleuch, introduced Jacobi's system. But the beginning of fish-culture on a national scale only dates from 1850, when the French Government instituted a large fish-hatching establishment at Huningue, in Alsace. At the present time America has profited most by the pursuit of fish-culture, which is largely practised with reference to their rivers and lakes. One type of hatching apparatus suitable for trout and salmon is represented in fig. 1208 as constructed by Dr. Ludwig Staby, and named by him "the deep Californian trough".

The fact that most marine fishes lay floating eggs renders fish-culture in their case comparatively easy, for any quantity of fertilized eggs can be collected from the surface of spawning-ponds

in which adult fishes are confined. In a hatchery for such fishes the eggs are placed in various receptacles, where they are kept aerated by suitable devices. MacDonald's hatching-bottle (fig. 1209) is largely employed in the United States for the small eggs of shad and other fishes, of which one bottle will accommodate about 70,000.

An important hatchery for cod has for some years been in operation at Flödevig, near Arendal, in Norway, under the superintendence of Captain Dannevig. In Scotland there is an important hatchery, chiefly used for plaice, connected with the marine station at Nigg, near Aberdeen, and there is also one at Piel, on the coast of Lancashire. There are, of course, important hatcheries for marine fishes in America.

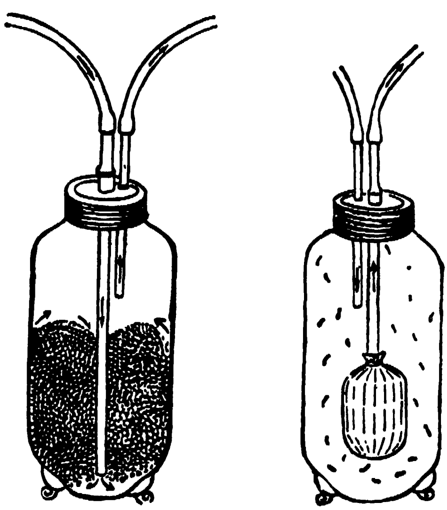


Fig. 1209.—MacDonald's Hatching Bottle. The one on the left is arranged for hatching purposes, and the other contains fry. Course of water indicated by arrows.

Regarding the value of hatcheries for freshwater forms, and fishes which, like the salmon, spawn in rivers, there can be no doubt. As to marine fish-hatcheries, which aim at maintaining or even increasing the supply by liberating great numbers of fry in the sea, the data are at present too incomplete to estimate their utility. It appears to be certain in some cases that good has been done by them, one instance of the sort being afforded by the Norwegian hatchery near Flödevig, but the expense involved is considerable, and for some species and some localities may well turn out to be so great as not to be justifiable. The large majority of the just-hatched fry which are now from time to time placed in the sea are destined to perish before growing to a marketable size, and it may in the end turn out to be necessary to carry the culture to a stage which will give a greatly increased chance of survival. But this is notoriously difficult, and a large amount of experiment is necessary before success is likely to be attained. And even in the event of the various obstacles being surmounted, the greatly increased expense of such a method may prevent its adoption.

There is a second possibility of exactly opposite kind, suggested by Cunningham, *i.e.* to give up hatching, and largely increase the extent of spawning-ponds, contenting ourselves with setting adrift vast numbers of fertilized eggs. Both the possibilities mentioned require testing on a large scale, and afford suitable objects for large Government expenditure. The money spent on a single battle-ship, or even on a cruiser, if devoted to this purpose, would quite conceivably settle the whole vexed question of British marine fish-hatcheries so far as some of the more important food-fishes are concerned. And unless scientific research, both pure and as applied to our important industries, fisheries of course included, is not far more largely endowed in future than it has been in the past, it may come about in the course of time that the country will be unable to afford a sufficient number of battle-ships, cruisers, and similar expensive necessaries.

MOLLUSCS (MOLLUSCA) AS FOOD

Brief mention has already been made (see p. 214) of various molluscs used for food in different parts of the world. A few of these are of such importance that they require somewhat more detailed treatment. They are Oysters, Mussels, Cockles, and Periwinkles.

The Oyster (*Ostrea*).—The most important European species is the "Flat" Oyster (*O. edulis*), to which our "natives" belong. There is also the large, somewhat triangular, Portuguese Oyster (*O. angulata*), which is of considerable economic importance, though of coarser kind. The American Oyster (*O. Virginiana*), commonly known in this country as "blue point", is the object of valuable and extensive fisheries on the Atlantic coast of the United States. In spite of typhoid scares it is probable that oysters will continue to be popular delicacies in this country, those from Whitstable and other fisheries in the Thames estuary being most esteemed.

Oyster Culture.—Some nations engage on a large scale in oyster culture as well as oyster fishing. Italy, Holland, France, and the United States may be particularly mentioned in this connection. This kind of culture mainly depends on the fact that the larvæ, fry, or "spat" readily attach themselves to various foreign objects, and can then be reared to "seed"

oysters, which may be further grown where produced, or else despatched elsewhere. The practice varies largely in different countries, and perhaps the most interesting case is afforded by France. It may be remarked in passing that the Italian oyster-industry has existed continuously from the times of the ancient Romans, and that the oysters are commonly grown upon bundles of twigs (*fascines*). The Dutch largely employ earthenware tiles, and the numerous estuaries of Holland afford suitable localities.

The large development of oyster-culture in France during the last few decades is very remarkable, and is the outcome of some experiments made in 1853 by M. de Bon, commissaire of marine at St. Servan. At that time the natural oyster-beds of France had been so much depleted by over-dredging that not only was strict legislation regarding them necessary, but the question of future supply naturally demanded attention. The observer mentioned found that the oyster-fry readily attached themselves to pieces of stone or stick, and this was the first step in the evolution of "collectors" to serve this end. The earliest attempts to revive the industry by artificial culture were unfortunately not successful, but many natural obstacles were gradually overcome, the final result being a flourishing and highly-specialized trade, in which there is much division of labour. The total annual value of the industry considerably exceeds half a million pounds sterling. In 1902 the fresh oysters imported into this country from France were worth £30,000.

Public dredging of the natural oyster-banks of France is so stringently limited by Government that they are of little importance as regards the direct supply of the market. They are, in fact, regarded as a reserve of spawning individuals, by which vast quantities of spat are produced. One important branch of the industry is to catch the spat on collectors ingeniously adapted to the conditions of particular localities. Some of these devices are made of boards, fixed together in successive tiers; but most of them consist of curved earthenware tiles, arranged in wooden crates, wired together, or otherwise associated (fig. 1210). Whatever their precise nature, they are mostly to be found fixed in their appointed places near low tide-mark or in shallow water, by the beginning of July, *i.e.* at the time when the fry are liberated from between the shells of the parent oysters. The tiles (or boards) have previously been covered

with a thin layer of a mixture of lime and sand (or mud), and it is the under surfaces which, under ordinary circumstances, serve for the attachment of the larval oysters when these give up a free-swimming existence for a sedentary life. It may be added that in some localities it has been found possible to construct large spawning-ponds instead of relying on the supply of spat from the oyster-banks off the shore.

Fig. 1210.—The Gabarét Collector (Ruche) in position (at Arcachon) Young oysters are seen attached to the tile which is being lifted, and to another that is up-ended on the right. The collectors are covered with sea-weed, so that when left by the tide they are kept moist, and protected from heat and light.

A "set" of spat having been secured on the collectors, the tender molluscs are left till about October, by which time they have grown to the size of a finger-nail, and are known as "seed-oysters". They are then flaked off the tiles (or boards), which the thin layer of lime renders possible with trifling loss, and carefully packed. This ends the stage of production (*production*), and the little oysters are now committed to the care of another set of specialists, who rear them to a marketable size. This process of *élevage* is much more difficult. The *éleveur* places the seed in rectangular rearing-cases, the upper and lower sides of which are chiefly made of wire-gauze. As

growth proceeds, sorting from time to time becomes necessary, so as to give increased room. The cases are placed in oyster "parks", which are simply enclosed areas of shallow water, with boundaries of the most various character, from lines of waving saplings to solid masonry pierced by flood-gates (fig. 1211). When the oysters have attained a fair size they may be trans-

Fig. 1211.—A Norwegian Oyster-Park

ferred from the cases to the floor of the park, which sometimes has to be specially prepared for their reception.

There are still two more stages which some French oysters have to go through before they reach the market. One is the process of "greening", as at Marennes, the products of which are greatly esteemed. The oysters are here kept for a long time in small and muddy salt ponds (*claires*), where they gradually acquire a green colour owing to the nature of the food available, which consists of minute algæ. At the same time a peculiarly delicate flavour is imparted. Healthy British oysters from the estuaries of the Roach and Crouch, in Essex, may also be

green, and for the same reason. Certain green oysters, however, should be looked upon with suspicion, as, for example, some of those from Cornwall, in which the colour is due to the presence of copper.

The last process to which some of the French oysters are subjected is that of education for transport. They are gradually accustomed to be out of water, and to close their valves closely, which clearly enables them to be sent in a good condition for long distances.

English Oyster-Industry.—That this industry is of considerable importance will already have been gathered from the statistics on page 280. We may take as an example the Whitstable Oyster Fishery Company, which is one of the most notable. As to its yield of oysters, the Secretary of the Company, Mr. W. H. Reeves, writes in a private letter: "With regard to statistics I can only say that our own sales of oysters average about 10 million to 12 million yearly, and of this number about two-thirds are English Natives and the rest imported from France, with a small percentage of East River oysters from America". As most persons are aware, Whitstable is on the north coast of Kent, east of the Isle of Sheppey, and has been an important seat of the oyster-trade from very remote times. The details here given are derived from a book by A. O. Collard (*The Oyster and Dredgers of Whitstable*), to which readers are referred for further information. The following quotation from this book will give an idea of the length of time for which "natives" have been popular:—"Among some valuable notes attached to the evidence taken on oath in the Committee of the House of Lords in 1866, on certain bills promoted by the Herne Bay Fishery Company, I find the following observations: 'The Whitstable Company are a most ancient body of 'free fishers

Fig. 1212.—Shell of a Whitstable Native, with young Oysters attached. Reduced.

and dredgers', who, from father to son, have carried on the business of an oyster fishery during, it is probable, a period of

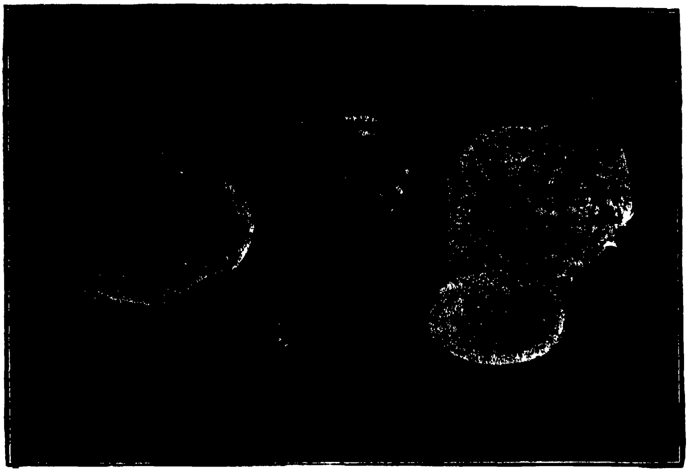


Fig. 1213.—Wheeler's Beehive Collector. Much reduced.

at least two thousand years. It was about A.D. 80 that Julius Agricola first exported oysters from the neighbourhood of the

Fig. 1214.—Whitstable Oyster-Dredger at Work. Dredges on the rail.

Reculvers to Rome, and for the ancestors of the Whitstable free dredgers Rome was, during about three centuries, their

Billingsgate.' . . . When we remember what is known of the early state of Great Britain, we can scarcely be surprised that Sallust, who lived and wrote about fifty years before Christ, had a better opinion of our oysters than our ancestors, for he said, 'The poor Britons—there is some good in them after all—they produce an oyster'. Whitstable may certainly claim some share in creating that good impression."

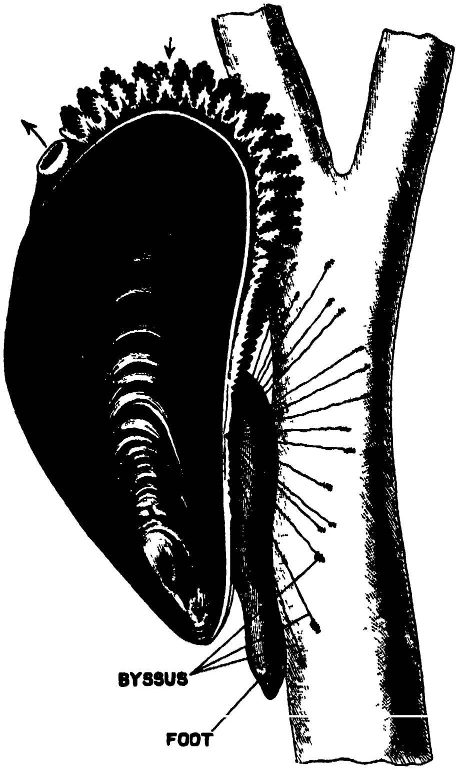


Fig 1215.—Edible Mussel (*Mytilus edulis*)

The superior quality of the Whitstable Natives is mainly due to the character of the in-shore beds where the oysters live, for not only is the soil favourable, but there is the necessary admixture of fresh water of suitable nature from the land. Upon these beds are planted the seed oysters dredged further out in the estuary, while some of these are imported from France. The "cultch" to which the bivalves attach themselves is largely made up of empty oyster-shells (fig. 1212). One ingenious method that has been tried for catching the spat is by means of Wheeler's Beehive Collector (fig. 1213), made of perforated earthenware, and partly filled with empty shells. Space forbids reference to the way in which the mature natives are treated after they have been dredged (fig. 1214) and before they are finally packed in barrels for the market.

The Edible Mussel (*Mytilus edulis*, fig. 1215).—This mollusc is used to a considerable extent as human food, though there is rather a prejudice against it on account of the fact that occasional batches turn out to be poisonous, causing serious illness or even death. That mussels are nevertheless eaten largely in England may be deduced from the fact that in 1902 no less a quantity

INTERTIDAL AND SHALLOW WATER ANIMALS

The plate represents a tide-pool on the British coast, and introduces a number of familiar marine animals. Beginning with those lowest in the scale they are:

1. Sea-Anemones (*Actiniæ*).
2. Common Star-fish (*Uraster rubens*).
3. Acorn-Barnacles (*Balanus*).
4. Shore-Crab (*Carcinus mænas*).
5. Cockles (*Cardium*). The one on the left belongs to the edible species (*C. edule*).
6. Sea-Mussels (*Mytilus edulis*).
7. Scallop (*Pecten*).
8. Periwinkles (*Littorina*). Those on the right are of the edible sort (*L. littorea*), while the small yellow ones on the left belong to another species (*L. obtusata*).
9. Purple-Shells (*Purpura lapillus*).
10. Gulls (*Larus*).

A TIDAL POOL WITH FAMILIAR MARINE ANIMALS

1. Sea-Anemones. 2 Star-fish. 3. Acorn-Barnacles 4. Shore-Crab. 5. Cockles. 6. Sea-Mussels 7 Scallop. 8 Periwinkles 9. Purple-shells. 10. Gulls.

than 43 tons 10 cwts. of them was seized and condemned at and near Billingsgate Market. On the Continent the consumption is much greater than with us.

The mussel is greatly valued as a bait in British line-fishing, particularly on the coast of Scotland. The yield in that country for 1902 amounted to 95,663 cwts., valued at £5445, which contrasts strongly with the 247,186 cwts., worth £14,506, collected in 1892. The meaning of the steady diminution which has been going on for some years has reference to the displacement of line-fishing by trawling. The same thing has been happening with regard to "clams" (species of *Pecten* and various other bivalves), another valuable bait in Scottish line-fishing. The quantity of clams taken in 1892 was 20,769 cwts. (£2736), but in 1902 only 4320 cwts. (£586).

Mussel-Culture.—As in the case of the oyster, the eggs hatch out into free-swimming "fry", which after a time attach themselves to various objects, not, however, by the substance of one valve, but by silky byssus threads. Nor is the mussel obliged to spend the whole of its fixed life in one spot, for it can cast off the threads, and crawl away to some distance, if adverse circumstances render a change of residence desirable. Important musselries were established some years ago at Montrose, and previously barren ground was made very valuable. The principle involved essentially consists in reserving certain beds for the production of "seed", as in the case of the strictly-preserved natural oyster-banks on the French coast (see p. 289). From these beds the young mussels are collected and planted out on other areas.

On the Baltic coast of Germany tree-branches are thrust into the sea-floor in shallow water (fig. 1216), serving as collectors for the fry, which grow upon them to a marketable size. After from three to five years they are pulled up, weighed, and sold with their living crop still adhering.

At some points of the French sea-board, especially at Esnaudes on the west coast, elaborate mussel-farming is practised, on what is known as the "bouchot" system. Each bouchot is a V-shaped or W-shaped collection of stakes driven into the mud, with the opening directed seawards. Adjacent stakes are connected by interwoven branches, and the 500 bouchots of the Esnaude musselry have a collective length of not far short of

130 miles. During the first two months of the year the mussel-fry attach themselves to the bouchots next the sea, and by May have grown sufficiently large to be scraped off without difficulty. They are then placed in small bags made of old canvas and the like, which are fixed to stakes further from the sea. Ultimately the bags rot away, leaving the mussels hanging in bunches by their byssal threads. As time goes on they are transferred further and further landwards, till by the time the

Fig. 1216 —Part of a Baltic Musselry

innermost stakes are reached they are large enough to gather for sale. The annual yield of Esnaudes is valued at not less than £52,000.

The Cockle (*Cardium edule*).—As a cheap, if indigestible, substitute for the oyster this bivalve is largely eaten by the populace in this and other countries. It burrows in the sand or mud of bays and estuaries, and is captured by raking at low tide. Morecambe Bay, Caermarthen Bay, and the estuary of the Teign are notable localities. Statistics for this country are not available, for even in the Reports of the Scottish Fishery Board the

cockle is an "unclassified" shell-fish. But most of us have seen small detachments of this mollusc displayed for sale on stalls, with vinegar and pepper as accompaniments, and have speculated as to what kind of customer might be expected. And we have the significant fact that, in 1902, 7 tons 18 cwts. 2 qrs. of cockles were seized and condemned at or near Billingsgate Market.

The Periwinkle (*Littorina littorea*).—The popular 'winkle is gathered between tide-marks on many parts of our coasts, the greater part of the London supply being derived from Scotland. The large quantity of 54 tons 5 cwts. was seized and condemned at or near Billingsgate Market in 1902.

CRUSTACEANS (CRUSTACEA) AS FOOD

We are here chiefly concerned with Lobsters, Prawns, Shrimps, and Crabs (fig. 1217), though these are far from being the only edible species.

The Lobster (*Homarus vulgaris*).—Of all large crustaceans this is the most esteemed in this country, and vast numbers are annually consumed. Along the rocky parts of the coast of the British Isles, Norway, Canada, and many other countries, lobster-fishing is a very important industry. A large part of the English supply is derived from Scotland, for which the yield in 1902 was 786,400, valued at £37,114. The home-supply is by no means equal to the demand, and our imports of lobsters, fresh and canned, are very considerable. Of the former we relied upon Norway for 38,538 (worth about £1850) in 1902, and upon France for many more. Lobster-canning is an important industry for Newfoundland, Canada, and the United States. It should be added that the American Lobster (*H. Americanus*) is not of the same species as our native form, though closely allied.

Lobsters are caught in "pots" or "creels", contrivances of the nature of traps, constructed of a wooden framework covered with netting (fig. 1218). Fish-entrails or other garbage is used as bait, the creel being sunk in a suitable spot by means of stones, a cord with a cork at the end serving to mark the spot.

Lobster-fishing has to be regulated with considerable stringency, as it is only too easy to deplete the supply. Hatching has

been carried on to a considerable extent in several countries with a view to maintain or, if possible, increase the numbers available. The difficulties to be overcome are far less formidable than in the case of fishes, for the female or "hen" lobster carries about her

Fig 1217.—1, Common Prawn (*Palæmon serratus*). 2, Common Shrimp (*Crangon vulgaris*). 3, The Edible Crab (*Cancer pagurus*). 4, The Lobster (*Homarus vulgaris*)

eggs attached to the under side of the tail, at which time she is said to be in "berry". So long ago as 1887 Captain Dannevig, at the Norwegian fish-hatchery near Arendal, found it possible to rear lobster-fry from the eggs, and such rearing is now resorted to by Scotland, Canada, and the United States, among other countries. The Aberdeen hatchery, for example, liberated some

3000 minute lobsters during 1902. The value of these hatcheries is doubtful.

The Edible Crab (*Cancer pagurus*).—This savoury crustacean is also of considerable economic importance (see p. 280). The chief method of capture is the same as for the lobster. Hatching methods are here also being made the subject of experiment. The Aberdeen hatchery cast adrift in the open sea no less than 4,500,000 of juvenile crabs in the year 1902.

Shrimps and Prawns.—A Common Shrimp (*Crangon vulgaris*) is distinguished from a Prawn (*Palæmon serratus*, &c.) not only

Fig. 1218.—Crab-Pots

by its smaller size, but also by several structural features, of which the most obvious is the absence of the sharp saw-edged spine which projects from the head of the latter. Prawns are often known as "red shrimps". The annual consumption in this country must be very large, judging from observation, and the fact that in 1902 shrimps (presumably including prawns as well) to the amount of over 54 tons were seized and condemned at or near Billingsgate Market. We also know that in the year mentioned over 900 fishing-boats (mostly second class) were engaged in capturing shrimps and prawns, chiefly by trawls, round the coasts of England and Wales. The catch of three small third-class Scottish trawlers working for that period in the Solway Firth was worth £3571, and if the earnings of the English boats were

proportionate the total value of their catch must have been very considerable. And we have further to consider the great army of shrimpers working by means of various kinds of hand-net (fig. 1219), or dragging similar contrivances along by means of carts.

Fig. 1219.—Shrimper working a Push-Net

The Fresh-Water Crayfish (*Astacus fluviatilis*).—This inhabitant of many of our rivers and canals, which resembles a small lobster in appearance, is of no great economic importance to this country, although of decidedly delicate flavour. On the Continent, however, an allied but larger species (*A. nobilis*) is much eaten.

CHAPTER LXIX

ANIMAL FRIENDS—WILD ANIMALS CAPTURED FOR VARIOUS ECONOMIC PURPOSES—BENEFICIALS

The present section has mainly been concerned with the animal kingdom as a source of food, although in dealing with domesticated forms it has been found convenient to mention commodities of other kinds, such as wool.

We now have to deal with economic products other than food, for the sake of which wild animals of various kinds are captured. Prominent among these desiderata are furs, skins, fats, and oils, besides which there are a great number of less important articles of commerce, such as sponges and medicinal substances, that call for passing notice. Animal products employed entirely or mainly for decorative purposes will be reserved for treatment under Animal Æsthetics.

FUR-BEARING MAMMALS (MAMMALIA)

Although in temperate regions, as we have seen (p. 228), woven clothes have replaced for ordinary purposes the garments of skin and fur devised by prehistoric races, this by no means applies to the colder parts of the world, where ordinary clothing does not afford sufficient protection from the rigorous climate. The nomad tribes of the Russian steppes, for example, make large use of such garments, and the heathen Ostiaks of North Siberia do so to a still greater extent (fig. 1220). Of the latter Brehm says (in *North Pole to Equator*) that ". . . they use nothing but the skin of the reindeer for clothing, and only employ the furs of other animals for the occasional decoration of the reindeer, or, as the Russians call them, stag skins. Their dress consists of a close-fitting skin coat reaching to the knee; in the men it is slit down the breast, in the women it is open down the whole front, but held together with leather thongs; a hood of the same material is

usually attached to or forms part of the dress; mittens also are sewn on; leather breeches reach below the knee; and leather stockings, which fasten over the knee, complete the attire. The fur garment worn by the women is edged down the sides of the

Fig. 1220.—Heathen Ostiaks

opening with a carefully-pieced border of variously-coloured little squares of short-haired fur, and always has a broad band of dog-skin round the foot; that worn by the men has at most a border of dog-skin round the foot; the leather stockings, if they are decorated at all, are composed of many prettily-combined, diversely-coloured stripes of skin from the leg of a reindeer, with a stout

shoe partly sewn on, partly laced over the foot." The Esquimaux dress is spoken of elsewhere (see p. 227).

That we ourselves have not altogether abandoned the dress-materials of our remote prehistoric ancestors is sufficiently attested by the fact that in 1902 over 97,000,000 skins and furs, worth £5,578,452, were imported into this country, though of course only a part of these were destined for personal wear.

The list of fur-bearing Mammals is a very long one, but the most important orders in this connection are the Flesh-Eaters (Carnivora) and the Gnawers (Rodentia), and the purpose of the present section will be sufficiently attained by dealing with a few species belonging to these. It may be noted that we look to the colder parts of the world, especially Canada and Russia, for our chief supply, for the growth of a dense under-coat of fur is an adaptation to rigorous climatal conditions. And it is the pelts obtained in winter that are valuable. In 1902 Canada exported furs to the value of £98,000.

FUR-YIELDING FLESH-EATERS (CARNIVORA).—Some of the most important furs of commerce are derived from the members of the Weasel and Marten Family (Mustelidæ). Pre-eminent among these is the Russian Sable (*Mustela zibellina*), which formerly abounded throughout the forest regions of Siberia, but is now mostly to be found in the eastern part of that country, including Kamschatka, where the seaport of Petropavlosk is an important depôt for the pelts. A single skin may be worth as much as £30 in this country. The chief method of hunting is by means of dogs, which force the sables to take refuge in trees, from which they are shaken or knocked down into suitably disposed nets. The closely allied American Sable (*M. Americana*), largely trapped in Canada, is also of considerable importance.

The white skins (with black tails) known as "ermine", which custom leads us to associate with the "great ones of the earth", are no other than the winter coats of the Stoat (*Putorius erminea*), one of our native "vermin". It is widely distributed through the arctic and temperate regions of both Old and New Worlds, but only assumes full winter livery in the colder parts of its area of distribution.

The *Minks* or *Visons* are comparatively large aquatic animals of the weasel kind, with brown fur. The pelts of the American Mink (*Putorius vison*) are most esteemed, and are of importance

in the Canadian fur-trade. Those of the Russian Mink (*P. lutreola*) are less valuable.

Passing over Bears, Foxes, Leopards, &c., mention must be made of Sea-Otters and Fur-Seals, of which the latter in particular are of great economic importance.

The *Sea-Otter* (*Latax lutris*), native to the coastal waters of the North Pacific, has been so persistently hunted down that its numbers have rapidly diminished during the last twenty years, and it is probably doomed to speedy extinction. Spearing, clubbing,

Fig. 1221.—Northern Fur-Seals (*Otaria ursina*) on the Pribyloffs

and netting are the chief modes of capture. The fur of the adult is very dense, and of a beautiful dark colour. Owing to their rarity skins are now of great value, a single one being worth at least £100, or, in exceptional cases, double that amount or even still more.

Certain species of *Sea-Lions* or *Eared Seals* (Otaridæ) are the "fur seals" of commerce, which furnish the valuable skins with which most of us are familiar. Some of them are native to the Southern seas, but the most notable kind is the *Northern Fur-Seal* (*Otaria ursina*, figs. 1221 and 1222), or Sea-Bear of the Pacific. The Pribyloff Islands of the Behring Sea have long been famous as one of the most important centres of the industry to which this

THE SABLE (*Mustela zibellina*)

This small carnivore, a near relative of our native Pine-Marten, is one of the most valuable of fur-yielding animals. It formerly ranged across the northern parts of Asia, from the Urals to the Behring Sea, but has been so persistently hunted down that it is now chiefly found in the forests of eastern Siberia and Kamschatka, Petropavlovsk on the coast of the latter being the chief depôt for sable-skins. It is only the thick winter-fur that is valuable, and a good pelt may be worth as much as £30.

Sables were formerly caught for the most part by trapping, and sometimes guns were resorted to, though with great risk of injury to the skins. At the present time they are usually hunted down with dogs, and forced to take refuge in trees, from which they are shaken or knocked down into suitably disposed nets.

THE RUSSIAN SABLE (MUSTELA ZIBELLINA), THE KING OF THE MARTENS

species gives rise. As elsewhere briefly described (vol. iii, p. 492), large numbers of the fur-seals repair to these islands during the summer for the purpose of bringing up their young. It is the young "bachelor" males, or "holluschickie", that are not strong enough to secure establishments, which are slaughtered for the sake of their skins. These are carefully driven to inland "killing grounds", knocked on the head, and flayed as quickly as possible. Very full details of the industry are given by H. W. Elliot in his well-known book *An Arctic Province*, from which the following extract is taken:—"The common or popular notion in regard to seal-skins is, that they are worn by those animals just as they appear when offered for sale; that the fur-seal swims about, exposing the same soft coat with which our ladies of fashion so delight to cover their tender forms during inclement winter. This is a very great mistake; few skins are less attractive than a seal-skin is when it is taken from the creature. The fur is not visible; it is concealed entirely by a coat of stiff over-hair, dull, gray-brown, and grizzled. It takes three of them to make a lady's sack and boa; and in order that a reason for their costliness may be apparent, I take great pleasure in submitting a description of the tedious and skilful labour necessary to their dressing by the furriers ere they are fit for use. A leading manufacturer writing to me says: 'When the skins are received by us in the salt, we wash off the salt, placing them upon a beam somewhat like a tanner's beam, removing the fat from the flesh side with a beaming-knife, care being required that no cuts or uneven places are made in the pelt. The skins are next washed in water and placed upon the beam with the fur up, and the grease and water removed by the knife. The skins are then dried by moderate heat, being tacked out on frames to keep them smooth. After being fully dried, they are soaked in water and thoroughly cleansed with soap and water. In some cases they can be unhaired without this drying process and cleansed before drying. After the cleansing process they pass


Fig. 1222.—Northern Fur-Seals

to the picker, who dries the fur by stove-heat, the pelt being kept moist. When the fur is dry he places the skin on a beam, and while it is warm he removes the main coat of hair with a dull shoe-knife, grasping the hair with his thumb and knife, the thumb being protected by a rubber cob. The hair must be pulled out, not broken. After a portion is removed the skin must be again warmed at the stove, the pelt being kept moist. When the outer hairs have been mostly removed, he uses a beaming-knife to work out the fine hairs (which are shorter), and the remaining coarser hairs. It will be seen that great care must be used, as the skin is in that soft state that too much pressure of the knife would take the fur also; indeed, bare spots are made. Carelessly-cured skins are sometimes worthless on this account. The skins are next dried, afterwards dampened on the pelt side, and shaved to a fine, even surface. They are then stretched, worked, and dried, afterwards softened in a fulling-mill, or by treading them with the bare feet in a hogshead, one head being removed and the cask placed nearly upright, into which the workman gets with a few skins and some fine hardwood saw-dust, to absorb the grease while he dances upon them to break them into leather. If the skins have been shaved thin, as required when finished, any defective spots or holes must now be mended, the skin smoothed and pasted with paper on the pelt side, or two pasted together to protect the pelt in drying. The usual process in the United States is to leave the pelt sufficiently thick to protect them without pasting. In dyeing, the liquid dye is put on with a brush, carefully covering the points of the standing fur. After lying folded, with the points touching each other, for some time, the skins are hung up and dried. The dry dye is then removed, and so on, until the required shade is obtained. One or two of these coats of dye are put on much heavier and pressed down to the roots of the fur, making what is called the ground. From eight to twelve coats are required to produce a good colour. The skins are then washed clean, the fur dried, the pelt moist. They are shaved down to the required thickness, dried, working them some time while drying, then softened in a hogshead, and sometimes run in a revolving cylinder with fine saw-dust to clean them. The English process does not have the washing after dyeing.' "

Fur-Seals are also hunted in the open sea, at times when the herds are migrating. The United States endeavoured to put an

end to this "pelagic" sealing in the Behring Sea on the part of other nations, but the matter being submitted to arbitration, it was decided that, subject to certain restrictions, the practice should be allowed to continue. The yield of the fur-seal industry of British Columbia in 1900 was 35,523 skins (value $562,845), and in 1901 24,422 skins (value $366,330).

FUR-YIELDING GNAWERS (RODENTIA).—Beaver, Chinchilla, Musquash, Squirrel, and Rabbit are here of greatest importance.

Fig. 1223.—Musquash (*Fiber zibethicus*)

The Beaver (*Castor*).—The American Beaver (*Castor Canadensis*) is largely trapped in Canada for the sake of its fur, which is greatly esteemed, though no longer used in the manufacture of top-hats, silk having proved both cheaper and better for the purpose. The animal has been slaughtered in so wholesale a manner that beaver-fur is becoming increasingly rare and expensive.

The European Beaver (*C. fiber*), once abundant, is now too scarce to be of economic value. Regarding the value attached to the skins of those which existed in Wales down to 1188, Beddard (in *The Cambridge Natural History*), after stating that the species was extinct in England before the historic period, remarks: " . . . they were rare in the Principality for a hundred years or so before

the Norman Conquest. The king Hywel Dda, who died in 948 A.D., fixed the price of a Beaver skin at 120 pence, the skins of Stag, Wolf, and Fox being worth only 8 pence apiece."

The Musquash (*Fiber zibethicus*, fig. 1223).—This is a large North American vole, which is of considerable importance to the Canadian fur-trade, chiefly, it would seem, because it is made into imitation seal-skin.

The Chinchilla (*Chinchilla lanigera*).—The cold climate to which the soft gray fur of this pretty little rodent is an adaptation, is here a result not of latitude but of altitude. Chinchillas live in the high Andes of Peru and Bolivia, and are something like squirrels in appearance, except that the tail is far less bushy (see vol. i, p. 134).

The Common Squirrel (*Sciurus vulgaris*).—This species has a remarkably wide distribution, ranging from Ireland to Japan, and also being native to North Africa. It is the chief source of "squirrel" fur, which is of grey or drab colour, quite unlike the reddish-brown of our ordinary native specimens. The skins of commerce are, in fact, taken from individuals inhabiting the colder parts of Russia, the grey hue being, as in many other cases, an adaptation to the severe climate of winter.

The Rabbit (*Lepus cuniculus*).—Among the cheaper kinds of fur that of the rabbit is best known, and by means of dyeing and other processes it is worked up into passable imitations of more costly pelts.

SKINS AND DOWN OF WILD BIRDS (AVES)

Deferring for the present the question of the wild birds which are subjected to wholesale butchery on account of their beautiful plumage, mention may here be made of Grebes and Eider-Ducks.

Grebes (species of *Podicipes*).—These widely-distributed aquatic birds are distinguished by the density and beautiful silver-white colour of the plumage on the under side of the body. Muffs and other articles made of "grebe" are manufactured from the skin of this region, with the feathers attached as in nature.

Eider-Ducks (*Somateria*, fig. 1224).—Two species of these essentially Arctic birds are of commercial importance on account

of the valuable down developed on the nest as a climatal adaptation. The Common Eider (*Somateria mollissima*), which has a wide range, and is included in the British avifauna, is carefully preserved in Iceland and Norway. In Labrador and Greenland it is replaced by an allied species (*S. Dresseri*).

The Scandinavian eider-industry is based on the fact that the female bird lines and covers her nest with down plucked from her own breast (see p. 60). The breeding-places are on low ground near the coast, or upon rocky islets, and each "eder-fold" (*i.e.* eider-fold) is worked for profit by a special proprietor. Both eggs and down are collected at regular intervals during the nesting-season, but the amount obtainable from a particular nest

Fig 1224.—Eider-Drake (*Somateria mollissima*)

is, of course, limited, and care is taken to allow the despoiled mother-birds to hatch out some at least of the final batch of eggs. The last lot of down is collected when the nests have been deserted for the season. About three-quarters of the Danish supply is derived from Greenland. Newton (in *A Dictionary of Birds*) thus disposes of two popular errors regarding these birds:—"The story of the drakes furnishing down after the duck's supply is exhausted is a fiction. He never goes near the nest. . . . Equally fictitious is the often-repeated statement that eider-down is white. Mouse-colour would perhaps best describe its hue."

WILD ANIMALS YIELDING LEATHER, HORN, FAT, ETC.

It has been considered desirable in this book to deal with domesticated animals in a special section, but the plan (like any other) has certain disadvantages, especially when treating of

economic products. Leather, horn, fat, &c. &c., are, of course, derived from both tame and wild animals, and this must be kept in mind here. The importance of leather and horn will be realized by reading the following extracts from Simmonds (in *Animal Products*):—"The leather manufacture is one of our most ancient and important industries. . . . The old adage that there is nothing like leather is certainly verified in the multifarious uses to which leather has been or is now put. We make coverings of it in articles of personal use, for a man may be clothed in leather garments from the head to the foot. In saddlery and harness its use is universal, and nothing can supplant it for durability. In articles for household or domestic use, we have leather hangings and coverings for furniture, buckets and bottles, cups and hose. . . . For travelling we have portmanteaus, valises, and hand-bags, pocket-books, purses, and cigar-cases. . . . We write on leather, and we cover our books with it, and it has even been used by photographers to take likenesses on. It is the packing and baling material in many countries from its cheapness and durability. Hammocks, boats, and even cannon have been made of it, whilst the leather apron is the most durable and serviceable protection for many an artisan. Leather shields were and are still in use in many countries. It serves for the grip-handle of swords, and for the sheaths of knives. We use leather in balls for cricket and football, and we cover musical instruments with it, as well as telescopes and many philosophical instruments, for protection. It is the most ancient, useful, and generally applied animal substance for an infinite variety of purposes. And, moreover, leather can be made of the skin or hide of almost every quadruped, and of many fishes, serpents, and reptiles. Human skin has even been tanned, but it is too thin for any serviceable use." In the following remarks about horn it will be remembered that the antlers of deer are of bony nature:—"The rights and privileges of the 'horn-workers' and 'horn-pressers' in former times occupied the prominent attention of the Legislature. But there is no fear in the present day 'of the trade being ruined, and the business lost to the nation', as was the cry when the statutes 6 Edward IV, c. 1, and 7 James I, c. 14 were passed, forbidding the sale of horns to foreigners, and prohibiting the export of our wrought horns. The invention of horn lanterns has been by some ascribed

to King Alfred, who is said to have first used them to preserve his candle time-measurers from the wind. . . . A lantern [was formerly] an indispensable family article; there was no going into the yard or out of the door on dark nights without one. A piece of horn was sometimes placed over the title of mediæval MSS. to preserve the letters from injury, while the transparent material allowed them to be read. The child's horn-book of later times had its leaves of alphabet and spelling covered entirely with thin sheets of this material. Although the principal manufacturing applications of horn are for combs, umbrella-tops, and knife-handles, yet there are other uses as extensive and varied as the descriptions of horn which come into the market, or bristle on the head of the animals characterized by these frontal appendages. Ox, buffalo, and deer horns are those mostly worked up, but the horns of the rhinoceros, ram, goat, and some other animals are also employed to a limited extent for different purposes. . . . While many of the former uses of horns for glazing purposes, for drinking-cups, for horn-books, and for the bugle of the bold forester have passed away, other and more elegant and varied applications have been found for this plastic and durable substance. Extensive as is the present use of horns, we believe that many further manufacturing purposes may be found for them, and that they will become even still more important in a commercial point of view. They receive a great variety of applications at the present day, owing to their toughness and elasticity, as well as their remarkable property of softening under heat, of welding, and of being moulded into various forms under pressure." It may be added that for many purposes both leather and horn are now replaced by cheap substitutes.

As most of the horns used on a large scale for manufacturing purposes are those of oxen, it will suffice to devote the rest of this sub-section to the consideration of certain wild animals captured chiefly for the sake of the leather and fat which they yield.

The Walrus (Trichechus rosmarus).—This huge aquatic carnivore, which may attain the weight of 3300 lbs., is a purely Arctic form, and once abounded in the Behring Sea, the Gulf of St. Lawrence, and on the coasts of Newfoundland and Labrador. Like so many other wild animals, however, it has been so much

hunted down that the walrus industry is a declining one. Rifle, lance, and harpoon are all employed in its destruction. The economic products are skin, fat, and ivory. The skin is very thick and tough, but tanning reduces its value. It is employed for some of the coarser purposes to which leather is put, and in former times was largely used in North Europe for making ropes and cables, to which end strips of it were plaited together. The fat or blubber, though of good quality, is yielded in relatively small quantities. The ivory making up the large tusks is inferior to that of the elephant.

SEALS (PHOCIDÆ).—These are often confounded with the Fur-Seals (Otaridæ) and their allies, from which, however, they are distinguished by their more complete adaptation to an aquatic life, as seen more particularly in the complete absence of an external ear, and the backwardly-directed hind-flippers, which are bound together by a fold of skin (see vol. iii, p. 78).

Seals are hunted for the sake of their blubber, which makes excellent oil for lighting and lubricating purposes; and also on account of the value of their skins, which are dressed as one of the coarser furs; while they yield leather that, especially when enamelled, finds increasing favour. The animals are killed by clubs, harpoons, or rifles, according to circumstances. By far the most important species for the sealing industry is the Harp or Greenland Seal (*Phoca Grœnlandica*, fig. 1225), the former name of which has reference to the presence of a curved black mark on the back of the male. Next to this species in importance, and like it native to the Arctic Ocean, is the curious Hooded or Bladder-Nosed Seal (*Cystophora cristata*), so named from a dilatable swelling on the nose of the male. The most noted sealing centres are the coasts of, and the parts of the sea adjacent to West Greenland, Newfoundland, Jan Mayen Island, and North Russia (including the White Sea and the vicinity of Nova Zembla). From the British stand-point it is most interesting to notice that sealing is one of the chief industries of Newfoundland, its products in 1902 reaching the value of £166,747. The young are born on ice-floes, the "whelping ice", off the coast of Labrador, during January and February, and do not take to the water for about three months. The cold Labrador current, which sets southward along the American coast, brings the "whelping ice" to the latitude of Newfoundland by about mid-March,

and the well-equipped steam-sealers of St. John's begin their annual sealing-trip at the commencement of that month, timing their journey to reach the floes before the "whelps" are old enough to leave the ice.

Lake Baikal and the Caspian Sea were once connected with the Arctic Ocean, one proof of which is found in the fact that each is inhabited by a special kind of seal (*Phoca Sibirica* and *P. Caspica*), both of which are largely captured by means of

Fig 1225.—Harp or Greenland Seal (*Phoca Grœnlandica*)

strong wide-meshed nets, worked on the same principle as the "drift-nets" used for catching herring and mackerel. The Caspian sealers let down their nets from boats, those of Lake Baikal take advantage of the holes in the ice, to which the seals come up in order to breathe.

THE DUGONG (HALICORE DUGONG).—This member of the order of Sea-Cows (Sirenia), which ranges from Ceylon to East Australia, is, when adult, about the size of an ox, and is captured for the sake of its flesh, fat, and hide. Its pursuit is one of the Queensland industries, and harpooning is the method adopted. Semon (in *In the Australian Bush*) says of it:—

"The whites capture dugong principally for their fat, which is said to possess therapeutic qualities. It is considered an excellent remedy for consumption, but, happily for the dugongs, this seems to be a mere superstition. I have not tasted their meat myself, though some whites are very fond of it, and compare it to veal. Others, however, describe its taste as disagreeable and insipid. The aborigines of Torres Straits consider it a great delicacy." The hide is thick and tough, rendering it suitable for machine-straps.

WHALES, &c. (CETACEA).—Whales and their kind have been systematically hunted down from very remote times, chiefly for the sake of their fat or blubber, but some species also for their baleen or "whale-bone", and others on account of the value of their skins. As elsewhere stated (p. 209), the flesh of cetaceans is regarded as a great luxury by the Esquimaux and many other primitive peoples. A distinction is drawn between the Toothed Whales and the Toothless Whales, in which transverse plates of baleen, with fringed edges, hang down from the roof of the mouth (fig. 1226), serving as a sort of strainer by which water is removed from the plankton used as food.

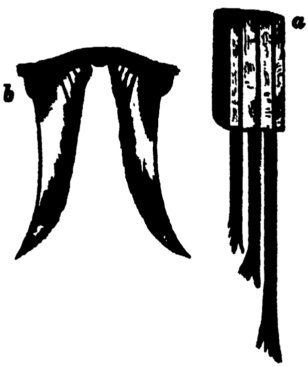


Fig. 1226.—Baleen. *a*, Three plates in section; *b*, a pair of plates. Greatly reduced.

Toothless Whales (*Mystacoceti*).—The most important member of this group is the Greenland or Northern "Right" Whale (*Balæna mysticetus*), a purely Arctic species. The British whaling industry, of which the chief ports engaged are Peterhead and Dundee, is chiefly concerned with the capture of this animal, but unfortunately has greatly declined of late years. To Newfoundland the pursuit of whales is a matter of much greater relative importance.

The old method of capture was from open boats, by means of harpoons thrown by hand, lances being afterwards used to despatch the wounded animals. The harpoon-gun afforded an improvement upon this, while a modern steam-whaler can dispense with the use of open boats, and discharge harpoons (sometimes loaded with explosives) from a platform in the bows.

Adult Greenland whales now attain a length of 50 or 60 feet, but much larger specimens were often captured in the palmy days of the whaling industry. The average product from a single animal is said to be about 15 tons of oil and 15 cwts. of whalebone. The former, like that of seals, is valuable as a lubricant and for other technical purposes, but the discovery of petroleum has greatly lessened the value of this and other animal fats as a source of artificial heat and light. Whalebone is becoming increasingly expensive in proportion to the diminishing supplies, and is still in great demand for a number of purposes, owing to its toughness, durability, and elasticity. It is now largely replaced by steel, as, *e.g.*, for umbrella-frames and corsets.

The Southern "Right" Whale (*B. australis*), which closely resembles the Greenland form, though its baleen is not of such good quality, has a very wide area of distribution, but is absent from the Arctic Ocean. The chief interest attaching to it is that at one time it was common in the Bay of Biscay, where it formed the object of an important industry, especially to the Basques of North Spain. Some points relating to this are thus summarized by Beddard (in *The Cambridge Natural History*):—
"Among the small towns which fringe the bay it is very common to find the whale incorporated in the armorial bearings. 'Over the portal of the first old house in the steep street of Guetaria', writes Sir Clements Markham (*P. Z. S.*, 1881), 'there is a shield of arms consisting of whales amid waves of the sea. At Motrico the town arms consist of a whale in the sea harpooned, and with a boat with men holding the line.' Plenty of other such examples testify to the prevalence of the whaling industry on these adjoining coasts of Spain and France. It appears that though the fishery began much earlier—even in the ninth century—the first actual document relating to it dates from the year 1150. It is in the shape of privileges granted by Sancho the Wise to the city of San Sebastian. The trade was still very flourishing in the sixteenth century. Rondeletius the naturalist described Bayonne as the centre of the trade, and tells us that the flesh, especially of the tongue, was exposed for sale as food in the markets. M. Fischer (*Actes Linn. Soc. Bordeaux*, 1881), who, as well as Sir Clements Markham, has given an important account of the whaling industry on the Basque shores, quotes an account of the methods pursued in the sixteenth century. It was at Biarritz

—or as Ambroise Pare, from whom Fischer quotes, spelt it, Biaris—that the main fisheries were undertaken. . . . The inhabitants set upon a hill a tower from which they could see 'the balaines which pass, and perceiving them coming partly by the loud noise they make, and partly by the water which they throw out by a conduit which they possess in the middle of the forehead.' Several boats then set out in pursuit, some of which were reserved for men whose sole duty it was to pick out of the water their comrades who had overbalanced themselves in their excitement. The harpoons bore a mark by which their respective owners could recognize them, and the carcass of the animal was shared in accordance with the numbers and owners of the harpoons found sticking in the dead body of the whale. At this period the fishery was at its height, but it continued to be an occupation along those shores until the beginning of the eighteenth century, after which it gradually declined. The fishery of whales began to be carried farther afield than the shore, and for a long time the Basques furnished expert harpooners to whaling vessels proceeding to the Arctic seas."

Toothed Whales (*Odontoceti*).—The largest of these is the Cachalot or Sperm Whale (*Physeter macrocephalus*, fig. 1227), which has been credited with reaching a length of over 80 feet, though this is probably an exaggeration. It ranges throughout the warmer seas of the world. The great head possesses a squarish snout that projects in front of the mouth, which is consequently placed on the under side of the body, obliging the Cachalot, it is said, to turn over like a shark when it wishes to bite. Many stories are current regarding the fierceness of this animal, and no doubt many whale-boats have been crushed in its formidable jaws, but that whaling and other vessels have at times been reported "missing" as a result of the attacks of Cachalots, as has been suggested, would appear to be more problematical. Like other cetaceans, this whale has a thick coat of blubber under the skin, and the front part of the skull is modified into a curious basin-shaped receptacle, which is full of the liquid fat known as spermaceti. As much as forty-five barrels of this have been taken from a single individual. Mixed with a small percentage of bees'-wax it was formerly much used in manufacturing candles of the better sort.

The White Whale or Beluga (*Delphinapterus leucas*) is an

Arctic species related to the Dolphins and Porpoises. The average length of adults is about 10 feet, but this may be considerably exceeded. It is chiefly hunted on the north of Russia and north-east of Canada, and is one of those cetaceans which ascend rivers. The blubber is of good quality, and the skin is made into the "porpoise leather" of commerce, which is of considerable value for the manufacture of shooting-boots and some other articles.

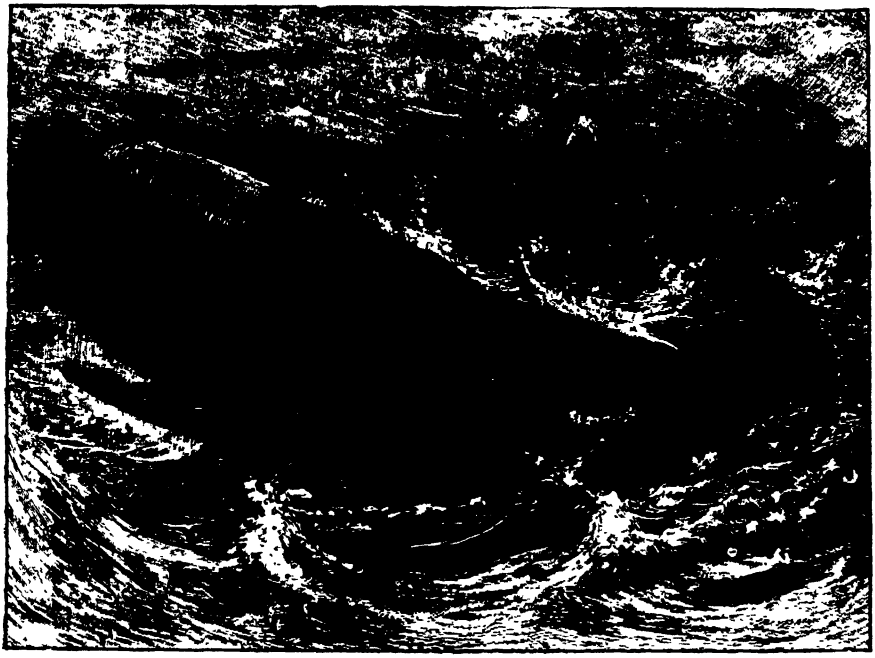


Fig. 1227.—Cachalot or Sperm Whale (*Physeter macrocephalus*)

REPTILES (REPTILIA).—It need only be said here that ornamental leather is made from the skins of Crocodiles and various Lizards, while "tortoise-shell" is obtained from certain Turtles. Of the last something will be said in a succeeding section.

FISHES (PISCES).—The skins of various members of this group are of economic value. Those of certain sharks and dog-fishes, for instance, are the source of "shagreen", used to some extent as ornamental leather, but chiefly for polishing wood. Their value for the latter purpose depends upon the fact that they are full of little hard-pointed scales, covered with enamel. The skins of some of the ordinary bony fishes (Teleostei) are employed for

clarifying beer, while in Eastern countries, such as India and China, they are converted into fish-glue, which is a very powerful adhesive.

Other fishes serve as a source of oil for technical purposes, as, *e.g.*, the Menhaden or Pogy (*Clupea menhaden*), a member of the herring family. This species is largely captured on the eastern coasts of the United States for this particular purpose. The livers of sharks and dog-fishes are also of considerable value as a source of oil.

INSECTS (INSECTA).—One would scarcely expect this group to be included under the present heading, but it appears that in Algeria locusts are utilized in the preparation of a kind of oil.

MEDICINAL AND MISCELLANEOUS ECONOMIC PRODUCTS

ANIMALS AND ANIMAL PRODUCTS AS MEDICINAL AGENTS.—In former days large use was made of animals in medicine, the prescriptions being usually fanciful and often revolting. To consider these ancient practices at length would be here superfluous, and the subject will be sufficiently illustrated by the following quotation from Hulme's *Natural History Lore and Legend*, a book in which much curious matter is brought together:—"Cogan in his *Haven of Health* declares 'thus much will I say as to the commendation of the hare, and of the defense of hunters' toyle, that no beast, be it never so great, is profitable to so many and so diverse uses in Physicke as the hare', and he then proceeds to give numerous prescriptions in which it is the principal feature. 'The knee-bone of an Hare taken out alive and worne abute the necke is excellent against Convulsion fitts', we are told, and perhaps it may be so, but the point that more especially strikes us, and it impresses one over and over again in these mediæval recipes, is the cold-blooded cruelty and indifference to animal suffering that is shown in so many of them. Fried mice were considered a specific in small-pox, but it was necessary that they should be fried alive; while for cataract a fox should be captured, his tongue cut out, and the animal released; the member thus barbarously procured was placed in a bag of red cloth and hung round the man's neck. For erysipelas a favourite old remedy was to cut off one-half of the ear of a cat and let the blood drop on the part affected, while for fits one popular recipe was to take a mole

alive, cut the tip of his nose off, and let nine drops of the blood fall on to a drop of sugar: the swallowing of this was held to be a certain cure."

"The shrew-mouse, one of the most inoffensive of creatures, was by our ancestors held to be of terribly poisonous nature. Its bite was thought to be most venomous, and even contact with it in any way was accounted extremely dangerous. Cattle and horses seized with any malady that appeared to cause any numbness of the legs were at once reputed shrew-struck. 'It is a ravening beast,' quoth Topsell, 'feigning itself gentle and tame, but being touched it biteth deep and poysoneth deadly. It beareth a cruel minde, desiring to hunt anything, neither is there any creature that it loveth.' On whatever limb it crept was 'cruel anguish', often ending in paralysis. These calumnies have prevailed in many countries and for many ages, the Romans being as firmly convinced of the deadly nature of the shrew-mouse as any British rustic of a century ago. . . . Happily there was a certain antidote against the evil wrought by this malevolent beast. A large ash-tree being chosen, a deep hole was made in its trunk, and after certain incantations were made a shrew-mouse was thrust alive into the opening, and the hole securely plugged. 'A shrew-ash', says Gilbert White in his *Natural History of Selborne*, 'is an ash whose twigs or branches, when gently applied to the limbs of cattle, will immediately relieve the pain which a beast suffers from the running of a shrew-mouse over the part affected. Against this accident, to which they were continually liable, our provident forefathers always kept a shrew-ash at hand, which when once medicated would maintain its virtue for ever.' One of these shrew-ashes, now but a fragment of what was evidently once a massive stately tree, may still be seen (1895) near the Sheen Gate in Richmond Park, and there are those still living who can remember cattle and horses being brought to it for its healing virtues."

"To cure a stye our forefathers had great faith in rubbing it with hairs from a cat's tail, two essential points being that the cat should be a black one, and that the operation should take place on the first night of the new moon; but to cure warts the hairs must be taken from the tail of a tortoise-shell cat, and even then the remedy is only efficacious during the month of May."

"Toads were in great repute in sickness. 'In time of com-

mon contagion,' writes Sir Kenelm Digby in 1660, 'men used to carry about with them the powder of a toad, and sometimes a living toad or spider shut up in a box, which draws the contagious air which otherwise would infect the party'; and many other illustrations of their employment as preventive or remedies might be given. The spider and the toad seem to have been each regarded as most venomous creatures, and in many of the old remedies one or other of them at will are recommended, either alternative being regarded as equally efficacious; thus for whooping-cough, if one cannot find a toad to thrust up the chimney, two spiders in a walnut-shell will serve equally well."

The physicians of former times were particularly fond of administering all sorts of animal extracts, some of them noisome enough, and it is somewhat curious that of recent times large use has been made of certain such extracts with beneficial result, though it need hardly be said that our modern methods of preparation are not on the old lines. Pepsin, for instance, a well-known aid to gastric digestion, is prepared from the lining of the pig's stomach, while pancreatin, which facilitates intestinal digestion, is obtained from the pancreas of domestic animals. Disease of the thyroid "gland" in the throat leads to serious mal-nutrition, or even to cretinism, palliation if not cure of which can be effected either by grafting a healthy piece of thyroid from an animal into the patient, or by administering thyroid extract. Several other preparations of the kind are also in use. Certain specific germ-diseases can also be prevented or combated by animal preparations, the most familiar instance being that of vaccination as a safeguard against small-pox. Diphtheria is now often cured by an extract (antitoxin) derived from horse's blood. Different principles are involved in the uses of the extracts, &c., mentioned, but details would here be out of place.

Various kinds of animal fat are used in pharmacy in the preparation of ointments, &c. They include mutton suet, hogs' lard, spermaceti, and lanoline, the last being the natural grease of wool. Gelatine is employed for making "gelatine lozenges" and various jujubes, also as the adhesive medium for "court plaster". It is obtained from bones, hides, horns, and hoofs by steaming. Isinglass (see p. 278) is a superior kind of gelatine.

It should not be forgotten that the careful study of the anatomy and physiology of lower animals has played a leading

VARIETIES OF THE FIELD-SNAIL (*Helix hortensis*)

Variation is one of the fundamental phenomena upon which the Evolution Theory is based. No two individuals of the same species are ever precisely alike, a fact familiarly illustrated by the dissimilarity which often exists between children of the same parents. It appears that all parts of the body are liable to variation, which may be of very marked kind and is no doubt, at least in part, due to the action of surroundings. A typical case, selected for this plate because it appeals to the eye, is that of the Field-Snail (*Helix hortensis*), of which some 90 races or varieties have been described. In some of these the shell is "self-coloured", yellow or pinkish-brown being common tints. In other cases there are in addition dark bands, the number of which is distinctive of the race, while the ground colour has also to be considered. Enough varieties have been introduced into the plate to illustrate the principle.

VARIETIES OF THE FIELD SNAIL (HELIX HORTENSIS)

part in the evolution of modern medicine. Without skilled researches on such animals it would never have been possible for operative surgery to reach its present high pitch of perfection. The prevention and cure of disease, other than by surgical methods, have also benefited greatly in the past by such investigations, and seem likely to benefit to a much larger extent in the immediate future.

Medicinal Value of Fish-Oil.—It need only be said here that the preparation of cod-liver oil, of which the Cod-Fish (*Gadus morrhua*) is the recognized source, is a by no means unimportant industry.

Medical Uses of Insects.—The Oil-Beetles (*Meloidæ* or *Cantharidæ*) are so called because they abound in an irritant sort of oil, which no doubt protects them to some extent from the attacks of insectivorous animals. Some of them are used to make preparations for blistering the skin, and of these "blister-beetles" the most notable are the "Spanish flies" (*Cantharides*), belonging to South and Central Europe. For commercial purposes a bright-green species (*Lytta vesicatoria*, fig. 1228), collected in Hungary, is most important. Various officinal extracts and plasters are prepared from the dried bodies of these insects.

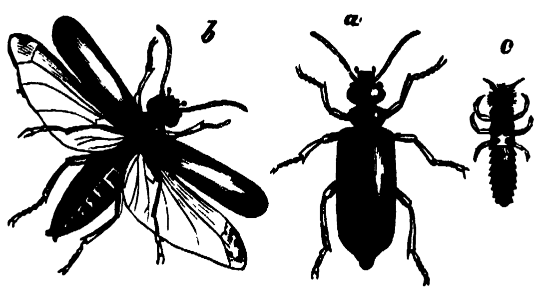


Fig. 1228.—Spanish Fly or Blister Beetle (*Lytta vesicatoria*) *a* and *b*, Adults; *c*, larva.

Although Cochineal, another insect product (see p. 260), appears to have no value as a drug, it is largely used to give liquid medicines an attractive appearance.

Medicinal Use of Leeches (*Discophora*).—Two kinds of Leech are used for blood-letting, the commoner being the Medicinal Leech (*Hirudo medicinalis*), which is mostly collected in Spain, France, and Italy. The Green Leech (*H. officinalis*) of Hungary answers the same purpose. In these days the extent to which these creatures are employed is comparatively small, but in the Middle Ages, when blood-letting was esteemed a sovereign cure for every ailment, the physician took his name from this favourite remedy, and was familiarly known as a "leech".

MISCELLANEOUS ANIMAL PRODUCTS.—It will be convenient to consider here a few odds and ends, which are difficult to place under other headings.

Miscellaneous Products of Molluscs (*Mollusca*).—The internal shell of the Cuttle-fish (*Sepia officinalis*, fig. 1229), under the name of "cuttle-bone", is ground up to form an ingredient of various tooth-powders. Before the invention of blotting-paper it was largely used (as also was fine sand) to sprinkle upon wet writing. It was known as "pounce", and a "pounce-box", with a perforated top, was part of the regular equipment of an old-fashioned inkstand or standish.

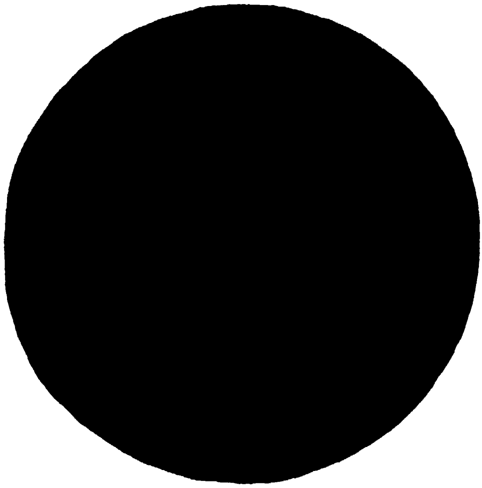


Fig 1229.—A Cuttle-bone

Cooke (in *The Cambridge Natural History*) makes the following interesting remarks about the miscellaneous uses of shells:—"The employment of shells as a medium of exchange was exceedingly common amongst uncivilized tribes in all parts of the world, and has by no means yet become obsolete. One of the commonest species thus employed is the 'money cowry' (*Cypræa moneta*, L., fig. 1230), which stands almost alone in being used entire, while nearly all the other forms of shell money are made out of portions of shells, thus requiring a certain amount of labour in the process of formation. . . . In British India about 4000 are said to have passed for a shilling, but the value appears to differ according to their condition, poor specimens being comparatively worthless. According to Reeve a gentleman residing at Cuttack is said to have paid for the erection of his bungalow entirely in cowries. The building cost him 4000 Rs. sicca (about £400), and as 64 cowries = 1 pice, and 64 pice = 1 rupee sicca, he paid over

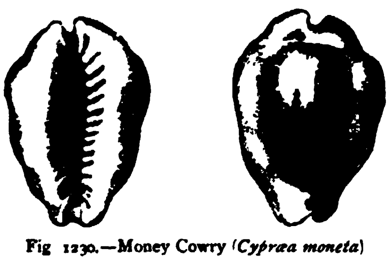


Fig 1230.—Money Cowry (*Cypræa moneta*)

16,000,000 cowries in all. Cowries are imported to England from India and other places for the purpose of exportation to West Africa, to be exchanged for native products. The trade, however, appears to be greatly on the decrease. At the port of Lagos, in 1870, 50,000 cwts. of cowries were imported. A banded form of *Nerita polita* was used as money in certain parts of the South Pacific. The sandal-wood imported into the China market is largely obtained from the New Hebrides, being purchased of the natives in exchange for *Ovulum angulosum*, which they especially esteem as an ornament. Sometimes, as in the Duke of York group, the use of shell money is specially restricted to certain kinds of purchase, being employed there only in the buying of swine. Among the tribes of the north-west coasts of America, the common *Dentalium indianorum* [a tusk-shell] used to form the standard of value, until it was superseded, under the auspices of the Hudson's Bay Company, by blankets. A slave was valued at a fathom of from twenty-five to forty of these shells, strung lengthwise. Inferior or broken specimens were strung together in a similar way, but were less highly esteemed; they corresponded more to our silver and copper coins, while the strings of the best shells represented gold. The *wampum* (fig. 1231) of the eastern coast of North America differed from all these forms of shell money, in that it required a laborious process for its manufacture. Wampum consisted of strings of cylindrical beads, each about a quarter of an inch in length and half that breadth. The beads were of two colours, white and purple, the latter being the more valuable. Both were formed from the common clam (*Venus mercenaria*), the valves of which are often stained with purple at the lower margins, while the rest of the shell is white. Cut small, ground down, and pierced, these shells were converted into money, which appears to have been current along the whole seaboard of North America from Maine to Florida, and on the Gulf Coast as far as Central America, as well as among the

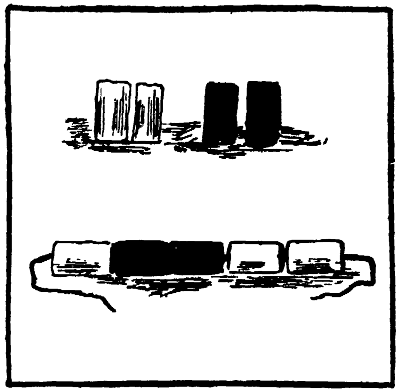


Fig. 1231.—Indian Wampum. Reduced.

inland tribes east of the Mississippi. Another kind of wampum was made from the shells of *Busycon carica* and *B. perversum.* By staining the wampum with various colours, and disposing these colours in belts in various forms of arrangement, the Indians were able to preserve records, send messages, and keep account of any kind of event, treaty, or transaction. Another common form of money in California was *Olivella biplicata*, strung together by rubbing down the apex. Button-shaped discs cut from *Saxidomus arata* and *Pachydesma crassatelloides*, as well as oblong pieces of *Haliotis*, were employed for the same purpose, when strung together in lengths of several yards."

Shells are put to various uses in the islands of the Pacific, as, *e.g.*, the making of fish-hooks, spoons, knives, and axe-heads. The ingenious Chinese convert the thin translucent shell of a flat bivalve (*Placuna placenta*) into window-panes, grind up cockle-shells for lime, or, by mixing the powder with oil, make a sort of putty.

Speaking of the West of Scotland, Anderson Smith (in *Benderloch*) thus describes an old-time practice:—"There is a curious old custom that used formerly to be in use in this locality, and no doubt was generally employed along the sea-board, as the most simple and ready means of arrangement of bargains by a non-writing population. That was, when a bargain was made, each party to the transaction got one half of a bivalve shell—such as a mussel, cockle, or oyster—and when the bargain was implemented, the half that fitted exactly was delivered up as a receipt. Thus a man who had a box full of unfitted shells might be either a creditor or a debtor; but the box filled with fitted shells represented receipted accounts. Those who know the difficulty of fitting the valves of some classes of bivalves will readily acknowledge the value of this arrangement."

Sponges (*Porifera*).—The horny skeletons of certain sponges have been used for toilet and other purposes since the times of the ancient Greeks. The best kind of Bath Sponge (*Euspongia officinalis*), known to commerce as "Turkey Sponge", comes from the Mediterranean and Red Sea, as well as the less esteemed Zimocca Sponge (*Euspongia zimocca*) and Horse Sponge (*Hippospongia equina*). Other kinds, both fine and coarse, are imported from the Bahamas, and sponges of commercial value are to be found off Australia and some of the South Sea Islands.

Three methods of sponge-fishing are practised in the Mediterranean, according to the depth of water. Where this is very shallow a five-pronged fork is employed, beyond the range of which (up to about 30 fathoms) diving is resorted to, while specimens growing in comparatively deep water (up to 200 fathoms) are dredged. The yield of the Italian sponge-fisheries for 1902 was worth £24,720.

WILD ANIMALS BENEFICIAL TO MAN ON ACCOUNT OF THEIR HABITS

From the economic stand-point many wild forms are of very considerable benefit to man, because they prey upon other creatures which are injurious to himself, his stock, and his crops. To some such animals we should extend the "protection" which they deserve at our hands, while for others equally beneficial (*e.g.* certain insects) we can do nothing in that direction. And it should be remembered that without very full knowledge it is very risky either to mercilessly persecute native forms, or to introduce species from other countries. The result of the ruthless slaughter of bats in a particular locality has been elsewhere mentioned (see vol. ii, p. 346), while the introduction of rabbits into Australia has led to unexpected and undesirable consequences.

Certain other wild species deserve the name of "beneficials" because they promote the health of mankind, or unconsciously assist in the work of agriculture, &c.

It will sufficiently serve the purposes of this work if the general nature of our indebtedness to certain groups of animals is indicated in a few paragraphs. For this and the other aspects of applied natural history readers who may be interested are specially recommended to consult Theobald's *First Report on Economic Zoology* (1902), one of the publications issued under the auspices of the British Museum (Natural History). This is rendered particularly valuable by the Introduction ("A Classification of Animals from the point of view of Economic Zoology") written by Ray Lankester. The word "beneficials" is applied by him in a somewhat narrower sense than it is here.

BENEFICIAL MAMMALS (MAMMALIA).—The destructiveness of Foxes, Weasels, Stoats, and the like, is so obvious, that the idea of their being "beneficials" would be scouted by many, though

they probably do more good than harm. The Fox, for instance, in spite of his ravages on poultry, destroys large numbers of field-voles and field-mice, together with noxious insects, such as cockchafers. And, of the Weasel (fig. 1232), Ritzema Bos says (in *Agricultural Zoology*):—"The weasel does some damage in fowl-houses and dove-cots, and is also destructive to game. This, however, does not outweigh its very great use, since it is above all an untiring vole-catcher. When in any region the field-voles have multiplied excessively, an immigration of weasels takes place from surrounding parts. In years when there is a plague of voles the usual breeding-time in spring is followed by another later on. A very large number of weasels may be found in a vole-infected district, and they thin out the mischievous rodents in a surprising manner. Nor are the weasels less useful in winter than in summer. They even follow under the snow the voles which winter in the country, and the slaughter effected at this period must exert a great influence on the following season, when these animals recommence their injurious work." The feelings of poultry-keepers and game-keepers are readily intelligible, but without full knowledge it is unwise to stigmatize as "vermin" apparently undesirable animals. Foxes only escape the libel for sporting reasons.

Fig. 1232.—Weasels (*Putorius vulgaris*)

The Insect-eating Mammals (Insectivora), such as Mole, Hedgehog, and Shrews, destroy enormous numbers of noxious insects and insect-larvæ, and are beneficials of the first rank. The mole is also of use in mixing and draining the soil. The vast majority of Bats (Chiroptera) feed on insects, and do much to keep down the numbers of the innumerable species which are injurious to stock and cultivated plants, as well as to forest-trees.

In the hotter parts of the globe some Mammals do useful work as scavengers, *e.g.* Hyænas (see vol. ii, p. 14). Rats and the like also act as sanitary agents.


Fig. 1233.—Barn Owl (*Strix flammea* and Nest

Beneficial Birds (Aves). — By destroying field-voles, &c., and small birds of injurious character, many of the smaller birds of prey, such as Kestrels, Buzzards, and Merlins, do much good, though it must be confessed that there is another side to the matter. Aflalo says of the Kestrel (in *Natural History of the British Isles*):—" Its food consists almost entirely of mice, so that its persecution is wanton folly ". Even should it prove requisite to classify any of our native species, unfortunately now existing in greatly diminished numbers, as " vermin ", they ought to be destroyed in a merciful way. Some of the steel traps used for slaughtering these and other wild animals (such as rabbits) are a disgrace to civilization, and only fit for the days of rack and thumb-screw.

Owls are more useful, but even more disliked than the diurnal birds of prey, partly as a result of the superstitions associated with them. Aflalo makes the following apposite remarks in this regard about the Barn Owl (*Strix flammea*, fig. 1233).—" Its disappearance from neighbourhoods where it once was plentiful is

The *African Secretary Bird* (*Serpentarius secretarius*) is a notable destroyer of poisonous snakes, and is domesticated by the farmers of South Africa for the sake of its services in this direction.

There are also scavenging birds, such as Vultures, which in hot countries discharge a most useful office.

BENEFICIAL REPTILES (REPTILIA).—Lizards are certainly to be regarded as beneficials, for they feed largely upon injurious insects and the like. Many Snakes are also useful, and some of them render conspicuous service by preying upon small rodents. Some species may even be domesticated on this account, as, *e.g.*, the Corn Snake (*Coluber guttatus*) in North America, and the Rat Snake (*Zamenis mucosus*) in India.

BENEFICIAL AMPHIBIANS (AMPHIBIA).—All the members of the class are beneficial, inasmuch as they live upon insects, snails, slugs, and other destructive creatures. Ritzema Bos states that . . . . "in the research garden attached to the Rouen entomological laboratory the snails were entirely exterminated in 1891, as a result of introducing a hundred toads and ninety frogs". The Toad in particular is one of the most useful animals that can be put into a garden, effectually protecting

strawberries from the ravages of slugs and performing other valuable offices of like nature.

BENEFICIAL FISHES (PISCES).—Much of the scavenging work in the sea and fresh water is efficiently discharged by members of this class. Among freshwater fishes Carp are particularly valuable in maintaining the purity of our drinking supply, keeping it free from insects, insect larvæ, and decaying matter. They are not infrequently kept in reservoirs on this account. And since the larvæ of such notorious pests as gnats, mosquitoes, and sand-midges are all aquatic, we are largely saved from annoyance and even from disease by the good offices of these and various other freshwater fishes.

BENEFICIAL INSECTS (INSECTA).—There are quite a large number of insects which either when adult or in the larval state, or it may be throughout life, are the natural enemies of many notorious insect pests. Sufficient examples have already been given in vol. ii, chap. ix, vol. iii, pp. 391–393, and in pp. 194, 195 of the present volume.

Carrion is also largely destroyed by insect-larvæ, such as the grubs of Burying-Beetles and the maggots of various Flies. Nor must we forget the large part which insects take in the fertilization of plants (see p. 83), including many which are of great importance to mankind.

BENEFICIAL SPIDER-LIKE ANIMALS (ARACHNIDA).—Of the members of this group it need only be said that Spiders, in particular, largely assist in keeping the numbers of insects within due limits.

BENEFICIAL MYRIAPODS (MYRIAPODA).—The numerous kinds of Centipede undoubtedly destroy large numbers of noxious ground-insects, and have therefore a claim to be included among beneficial animals.

BENEFICIAL CRUSTACEANS (CRUSTACEA).—A large amount of scavenging work is carried on by the members of this class, and, so far as the sea is concerned, Crabs are particularly notable in this respect.

BENEFICIAL ANNELIDS (ANNELIDA).—Earth-Worms render considerable service to agriculture (see vol. ii, p. 258) in more than one way. They reduce large quantities of soil to a finely-divided state, making it into a suitable seed-bed, bring earth to the surface as a sort of natural "top-dressing", and it may be added that their

burrows in the ground help on the work of drainage and aeration. *In short, the habits of* these animals benefit the land in much the same way as the operations of ploughing, harrowing, and the like.

BENEFICIAL PARASITIC WORMS.—At first sight one is rather *apt to* imagine that the members of the several groups of these *not altogether pleasing* creatures do nothing but harm. *This* is not, however, strictly true, *for* many of them pay special attention to noxious animals, and assist considerably in keeping down their numbers.

CHAPTER LXX

ANIMAL FOES—THE PERSONAL ENEMIES OF MAN

PERSONAL ENEMIES AMONG MAMMALS (MAMMALIA).—We are not justified in calling the fiercer and larger Mammals or other animals our enemies, simply because they defend themselves when attacked, and in most cases man will probably be found to have been the first aggressor. And even when that is not the case, at least when carnivorous forms are in question, casualties are usually the outcome of the Law of Hunger, or it may be parental solicitude.

Partly owing to its comparatively straightforward habits, the Lion (*Felis leo*), when left alone, does not attack human beings to the extent that might be supposed, unless pressed by hunger. Speaking of North-East Africa, Sir Samuel Baker says (in *Wild Beasts and their Ways*):—"In the locality which I have mentioned, the lions, although numerous, were never regarded as dangerous unless attacked; there was an abundance of game, therefore the carnivora were plentfully supplied, and a large area of country being entirely uninhabited, the lions were unaccustomed to the sight of human beings, and held them in respect. During the night we took the precaution to light extensive bonfires within our camp, which was well protected by a circular fence of impenetrable thorns, but we were never threatened by wild animals except on one occasion."

Where the country is thickly populated it is only to be expected that individual animals may at times acquire bad habits, or, as Vogt puts it (in *Mammalia*):—"Old experienced lions who know how little danger they are exposed to in breaking in upon the villages of the badly-armed negroes will, it appears, hanker after human flesh".

The stealthy cat-like habits of the Tiger (*Felix tigris*, fig. 1234) render it a good deal more dangerous to man than its

nobler cousin. But even the "man-eaters", which at one time undoubtedly accounted for a considerable number of the Indian natives, must have been but a small percentage of the tigers actually in existence. Of these once-dreaded marauders G. P. Sanderson gives the following graphic account (in *Thirteen Years among the Wild Beasts of India*):—"This truly terrible scourge to the timid and unarmed inhabitants of an Indian village is now happily becoming very rare; man-eaters of a bad type are seldom

Fig. 1234.—Tiger (*Felis tigris*)

heard of, or, if heard of, rarely survive long. Before there were so many European sportsmen as there now are in the country, a man-eater frequently caused the temporary abandonment of whole tracts; and the sites of small hamlets abandoned by the terrified inhabitants, and which have never been reoccupied, are not uncommonly met with by the sportsman in the jungles. The terror inspired by a man-eater throughout the district ranged by him is extreme. The helpless people are defenceless against his attacks. Their occupations of cattle-grazing or wood-cutting take them into the jungles, where they feel that they go with their lives in their hands. A rustling leaf, or a squirrel or bird moving in

the undergrowth, sets their hearts beating with a dread sense of danger. The only security they feel is in numbers. Though the bloodthirsty monster is perhaps reposing with the remains of his last victim miles away, the terror he inspires is always present to every one throughout his domain. The rapidity and uncertainty of a man-eater's movements form the chief elements of the dread he causes. His name is in every one's mouth; his daring, ferocity, and appalling appearance are represented with true Eastern exaggeration; and until some European sportsman, perhaps after days or weeks of pursuit, lays him low, thousands live in fear day and night. Bold man-eaters have been known to enter a village and carry off a victim from the first open hut. Having lived in a tract so circumstanced until I shot the fiend that possessed it, and having myself felt something of the grim dread that had taken hold of the country-side, where ordinary rambling about the jungles, and even sitting outside the tent after dark except with a large fire, or moving from the encampment without an escort, were unsafe, I could realize the feelings of relief and thankfulness so earnestly expressed by the poor ryots when I shot the Jezebel that had held sway over them so long. The man-eater is often an old tiger (more frequently a tigress), or an animal that, through having been wounded or otherwise hurt, has been unable to procure its usual food, and takes to this means of subsistence." In a recent article (in *The Sports of the World*) Lieutenant-general Sir Montagu G. Gerard thus speaks on this subject:—"Man-eaters are very rare indeed, and . . . probably become so accidentally. The accepted belief that they are necessarily mangy is a myth; it may be the cause, not the effect. For whatever reason, they seem to acquire preternatural cunning, and natives believe that the soul of a man is imprisoned within them. I once spent a fortnight following one, who never during that time killed within ten miles of her last victim. . . . A former colonel of the C.I. Horse, the most celebrated tiger slayer of thirty years back, killed an exceptionally mischievous one, which in a year had accounted for eighty-seven known victims. . . . I have only killed four undoubted ones, whose victims ranged from thirty-three to about a dozen apiece; but I have known of several others, generally sulky males, who had killed cattle-herds or wood-cutters disturbing them."

Of other members of the Cat family (Felidæ) large enough to

be dangerous to man, it need only be said that, since they are expert climbers, trees afford no refuge to human beings if they chance to be attacked.

Bears (Ursidæ), from their great strength and powerful claws, are dangerous antagonists when roused, but they can scarcely be considered the natural enemies of mankind, for most of them leave human beings alone unless provoked, or impelled by hunger. It may be gathered from accounts of Arctic expeditions, for example, that a hungry Polar Bear (*Ursus maritimus*) will not hesitate to attack men, and similarly for the Brown Bear of Europe (*U. arctos*), and the North American variety of that species commonly known as the "Grizzly". It is rather curious that the Indian Sloth-Bear (*U. labiatus*), which chiefly lives on fruit, honey, and insects, is somewhat given to turning upon our species, though, obviously, not as the result of hunger. At least Sir Samuel Baker says (in *Wild Beasts and their Ways*):—"This species is very active, and although it refuses flesh, it is one of the most mischievous of its kind, as it will frequently attack man without the slightest reason, but from sheer pugnacity". And under these circumstances the long-curved claws are capable of inflicting "terrible wounds upon a human being".

Wolves, when pressed by hunger, are destructive to human life in several countries, their habit of hunting in large packs greatly aggravating the danger, as everyone is aware. The annual casualties due to wolves in parts of the Russian Empire are by no means inconsiderable.

Even without special provocation some of the larger wild Mammals of purely herbivorous habit may injure or kill human beings, as in the case of Hippopotami, Buffaloes, Rhinoceroses, and Elephants. All have heard, for example, of "rogue" Elephants, ill-natured males which have been expelled from their herds for general misbehaviour. But details are here unnecessary. Some of the smaller forms, such as Wild Boars, are also dangerous, and the Peccaries (*Dicotyles*), which range from South America to Mexico and Texas, are even more so. A. G. Requa recounts the following amusing adventure (in *The Big Game of North America*) with a herd of White-lipped Peccaries (*D. labiatus*), which sufficiently illustrates their ferocity:—"I had not sat there more than five minutes before I heard the sharp noise of the Peccaries. They came in sight not more than twenty yards below me. There

were not more than a dozen that I could see, and there were plenty of small pines near by; so I thought that I would just kill the whole herd, provided they showed fight. As they came into the open ground they seemed to wind me, as they began to snuff and paw. I fired at one, and, just as I intended, only crippled him. He set up a great squealing, and, sure enough, here they came! I was just a little excited, and started for a tree, forgetting my coat and turkey. I had scarcely time to get up when they were around the tree, and instead of twelve, they kept coming till there were at least two hundred. I commenced shooting, and killed five with my rifle, that being the number of shells in my gun. It then occurred to me that my rifle-shells were in my coat; so, having no further use for my rifle, and realizing that it would become a burden to me if compelled to stay in the tree several hours, as seemed likely, I threw it down. Fortunately I had both revolvers, and a belt full of cartridges for them; so I went at them. They were chewing the tree, and climbing over each other trying to get at me. Each shot laid one out, and each shot seemed to make them more and more furious, as they would rush at the tree, and gnaw the bark and wood, while the white flakes of froth fell from their mouths. I tried to count them, and found that there were over two hundred left, and I had killed twenty-three. The position I had was not a comfortable one, but I had to stand it. Then for the first time I thought of the boys. Had they heard my shooting? if so, would they come? Then I remembered I had not fired the signal agreed on, and that I had followed the turkeys up the mountain and down again, and by this time the boys must be four miles up the cañon and on the opposite side. The Peccaries showed no signs of leaving. It was now noon, and very warm. They would root around, then come back to the tree, and grunt, and paw, and bite the tree; then they would cool down a little, would go a short distance away, root around awhile, then come back again. I was getting tired of being treed, but it was just what we had planned the night before, only we were not all together. If the boys could only hear my firing, and come over, how quick we would wipe them out! Such thoughts ran through my head; but still the pigs stayed. One o'clock came, then two; still they stayed. Then I thought I would fire a signal with my revolver—maybe the boys were hunting for me; so I made a noise, and back to the tree they came. I killed three

of them in about a second; then I waited. Three o'clock came, then four, and no sign of the boys. Some of the pigs would feed while the others stood guard; then they would change off. I was so tired I could scarcely stay in the tree; so I took my belt off and buckled myself fast to the trunk, so that I would not fall out. Seven o'clock! I could see no change; they still camped near me, showing no signs of weakening. Then the sun went behind the mountain; darkness came on, and I was thirsty, hungry, and tired; but, worse than all, I was a prisoner. Twelve o'clock! The moon shone brightly, and I could see my sentinels scattered around. Two o'clock! Then came a signal from some of the outside ones; the rest snuffed the air, then away they all went. I could hear them far below, going down the mountain. . . . Hereafter, anyone who wants to hunt Peccaries can hunt them, and be blanked; but I prefer some kind of game that is not so fond of human flesh as they are." Without the friendly tree the adventure might have ended differently, for the same writer tells us of these animals that—"If one of their number is wounded so that it squeals, the whole herd becomes ferocious, will charge their enemy on sight, and speedily destroy him, unless he escapes by climbing a tree or by flight".

The blood-sucking Bats have been spoken about elsewhere (see vol. ii, p. 39).

Personal Enemies among Reptiles (Reptilia).—The larger Crocodiles and Alligators are particularly destructive to human life, though their sphere of operations is obviously much limited by their aquatic habits. Speaking of Ega on the Upper Amazons, Bates says (in *The Naturalist on the Amazons*):—"Alligators were rather troublesome in the dry season. During these months there was almost always one or two lying in wait near the bathing-place for anything that might turn up at the edge of the water—dog, sheep, pig, child, or drunken Indian." With reference to Crocodiles in Madagascar, Sibree remarks (in *The Great African Island*): —"They are regarded with a superstitious dread by many of the Malagasy tribes, and are so dangerous in some parts of the island that at every village on the banks of the rivers a space is carefully fenced off with strong stakes, so that the women and girls can draw water without the risk of being seized by the jaws or swept off by the tail of these disgusting-looking creatures". Tales about the ferocity of Crocodiles are sufficiently numerous, many of them, of

course, having reference to that notable species, the Nile Crocodile (*Crocodilus Niloticus*, fig. 1235). The following remarks by Sir Samuel Baker (in *Wild Beasts and Their Ways*) will sufficiently illustrate the point:—"The throat of a crocodile is not only large, but is capable of great expansion, and although the habits of the creature usually permit the body of a victim to rest in quiet until it is devoured in piecemeal, there are many exceptions to the rule; large crocodiles will swallow a small person without the slower operation of dismemberment. . . . When I was in

Fig 1235 —Nile Crocodile (*Crocodilus Niloticus*)

command of the Khedive's expedition, our losses through crocodiles were very distressing, all of which were terrible examples of the ferocity, combined with cunning, which characterizes this useless scourge. On one occasion the vessels were sailing up the White Nile with a strong north wind, making at least 7 knots an hour; one of the cavasses was sitting upon the deck, with his legs dangling over the sides of the deeply-laden vessel, his feet being half a yard above the water. Suddenly a rush was made by a very large crocodile, and the man was seized and carried off in a shorter time than it would take to announce the fact. This was done in the presence of a hundred men on board the vessel, and nothing was ever heard of the unfortunate cavass."

Mention may here be made of the fact that two species of poisonous Lizards exist, both native to North America. One (*Heloderma horridum*, fig. 1236) is a Mexican form, while the other, commonly known as the "Gila Monster" (*H. suspectum*), inhabits New Mexico and Arizona. The sharp curved teeth of these creatures are grooved in front and behind for the purpose of conducting the poison, which is secreted by a series of small glands opening along the edge of the lower jaw. Of the Gila Monster,

Fig. 1236.—Mexican Poisonous Lizard (*Heloderma horridum*)

Gadow states (in *The Cambridge Natural History*):—"Frogs are probably paralysed or killed by the bite, which, although not so dangerous as that of poisonous snakes, is effective enough to produce severe symptoms even on man, and a few cases of death of people who had been bitten are on record".

Poisonous Snakes are among the most formidable personal enemies of man, and are justly dreaded in the countries they inhabit, which embrace all but the coldest parts of the globe. There is also reason to think that at least one of the larger non-poisonous snakes, *i.e.* the Anaconda or Water-Boa (*Euneces murinus*) of northern South America, may now and then crush and devour

human beings. This species is said to attain the length of 33 feet, or possibly more.

The mechanism by which a venomous serpent bites its victim, so as to introduce poison into the wound, has been described already (see vol. ii, p. 80), so does not require mention here. In justice to such creatures it may be said that, as a rule, they only attack human beings when interfered with, as, *e.g.*, by being accidentally trodden upon. Among the most dreaded species are the Indian Cobra (*Naia tripudians*); the even more dangerous Krait (*Bungarus cœruleus*) of the same country; the Australian Death-Adder (*Acanthophis antarcticus*); the Coral-Snake (*Elaps corallinus*) of tropical South America; the Sea-Snakes (*Hydrophinæ*) of the Indian Ocean; the African Puff-Adder (*Vipera arietans*); Russell's Viper (*V. Russelli*), native to South Asia; and the American Rattle-Snakes (species of *Crotalus*). The following remarks by Semon (in *In The Australian Bush*) will prove of interest:—

Fig. 1237.—Indian Cobra (*Naia tripudians*)

"It is decidedly no exaggeration to say that 500 persons are yearly bitten on the Australian continent, although the majority of these cases do not prove fatal. The population of Australia is at present supposed to amount to 3,000,000 [in 1901 it was nearer 4,000,000]. About 20,000 deaths by snake-bite are yearly reported from the British provinces of India, containing 120,000,000 inhabitants [population of India in 1901 was 294,266,701]. This record may indeed be somewhat exaggerated, and may owe its

enormity to conscious or unconscious deception of the magistrates by the native officials. Decidedly, however, the figures are not so much overrated as is frequently believed. In India, as well as in Australia, in the course of a year about one person in 6000 falls a victim to snake-bite."

PERSONAL ENEMIES AMONG FISHES (PISCES).—Some of the larger Sharks injure or devour bodily a good many human beings every year. The most notable is the Rondeletian Shark (*Carcharodon Rondeletii*), which ranges through the warmer parts of the ocean, and may attain the length of 40 feet.

Those fishes also which possess poisonous spines (see vol. ii, p. 355) may cause serious injury, while some species are poisonous as food, such, *e.g.*, as Globe-Fishes (*Diodon* and *Tetrodon*) and Coffer-Fishes (*Ostracion*).

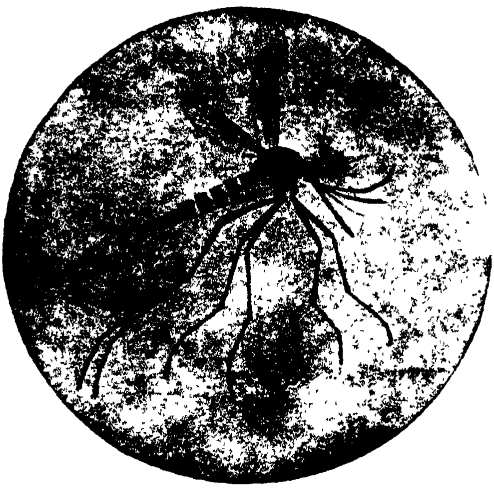


Fig. 1238.—A Gnat (*Culex*), enlarged

PERSONAL ENEMIES AMONG MOLLUSCS (MOLLUSCA). — Some of the giant Squids, and larger creatures of the Octopus kind, are certainly capable of injuring or destroying human beings. How far they do so, or have done so, it is impossible to say. And a few Sea-Snails, such as Cone-Shells (see vol. ii, p. 357), give poisonous bites.

PERSONAL ENEMIES AMONG INSECTS (INSECTA).—It is quite impossible here to pass in review the host of insects which bite or sting, and many of which make up by numbers what they lack in size. Bees, Wasps, Ants, Gnats (fig. 1238), Mosquitoes, Midges, Sand-Flies, Fleas, Bugs, and Lice are all more or less notable in their way, or perhaps notorious would be a better word. And many insects which do not bite or sting may nevertheless be a serious nuisance, *e.g.* House-Flies and Flesh-Flies.

But a fresh and unwelcome interest attaches to insects now that it is known that some of them are the means of conveying the germs of serious disease into the human body. The recent

work of Major Ross in reference to malarial fever is the best illustration that can be given. It appears that a particular sort of Mosquito (*Anopheles*) is infested with certain stages in the life-history of a parasitic animalcule (*Hæmamœba*) which are introduced into the blood of persons bitten. Further development is there possible, serious disturbances of the system resulting. And when the mosquito bites a human being whose blood harbours these further stages it is in turn infected. In short the mosquito infects man, and man infects the mosquito. Some of the details are given in fig. 1239. Fortunately the researches of Ross enable preventive measures to be adopted. The early part of the life of the insect is passed in stagnant water (compare vol. iii, p. 403), from which the immature stages can be cleared out by the use of petroleum, if applied at a suitable time. The method has been exceedingly successful at Havannah, formerly a great breeding-ground for yellow fever and other disorders of malarial type. The subject suggests another homily on the necessity for properly endowing scientific research.

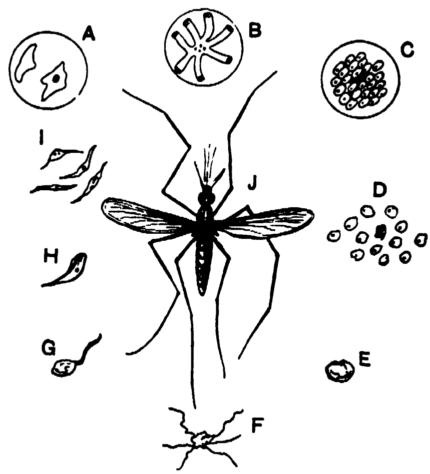


Fig. 1239.—Malaria Parasite (*Hæmamœba*)

A, Two parasites within a red blood-corpuscle of man; B, one of the same branching; C, division of same into minute spores; D, spores liberated by breaking up of the corpuscle; when taken up into the body of the mosquito with human blood some spores assume the form E, others the form F; G shows fusion of an E-spore with a thread from an F-spore; H, the fusion is complete, and at this stage the parasite pierces the wall of the mosquito's digestive tube; after complex changes the parasites reach the salivary glands of the insect, where the stage I is produced, which is introduced into the blood of a human being and attacks the red corpuscles; J, the mosquito (*Anopheles*). All but J greatly enlarged.

Personal Enemies among Spider-like Animals (Arachnida).—It need only be noted that Scorpions possess poisonous stings, while some of the larger Spiders inflict poisonous bites. At one time an exaggerated virulence was ascribed in Italy to the latter. Violent exercise was the reputed cure, hence the origin of the rapid dance known as a "Tarantella" (*i.e.* the diminutive of "Tarantula", the name of the spider).

The unpleasant skin-disease known as "Itch" is caused by the attacks of a kind of Mite (*Sarcoptes scabei*, see p. 196).

Personal Enemies among Myriapods (Myriapoda).—The

large Centipedes (Scolopendra) which abound in tropical countries are well known on account of their painful and poisonous bites.

Personal Enemies among Annelids (Annelida).—Some of the Leeches, especially the Land-Leeches of tropical countries, are peculiarly unpleasant to encounter (see vol. ii, p. 148).

Personal Enemies among Flat-Worms (Platyhelmia).—Among the Flukes (*Trematoda*) about eleven different species have been described as parasitic in human beings, including the kind which causes "liver-rot" in sheep, and which will be the subject of further notice. On one notorious scourge of the sort (*Bilharzia hæmatobia*) Gamble remarks as follows (in *The Cambridge Natural History*):—"This formidable parasite was discovered by Bilharz in 1853 in the veins of the bladder of patients at the Cairo Hospital, and is remarkable from its abundance on the east coast and inland countries of Africa from Egypt to the Cape, as well as in the districts bordering Lake Nyassa and the Zambesi river, while westwards it occurs on the Gold Coast. Mecca is a source of infection whence Mohammedans carry the disease to distant places. In Egypt about 30 per cent of the native population is affected by the serious disease known as hæmaturia, resulting from the attacks of *Bilharzia*, so that, of the many scourges from which in Africa man suffers, this one is perhaps the most severe."

A number of Tape-Worms (*Cestoda*) infest the human subject, and one example has been given in an earlier volume (vol. i, p. 441), *i.e.* the Common Tape-Worm (*Tænia solium*), which is a common consequence of eating "measly" pork in a partially cooked condition. Another not infrequent human parasite in Western Europe is the Beef Tape-Worm (*Tænia saginata*), derived from "measly" beef. The Broad Tape-Worm (*Bothriocephalus latus*), which is well known as a parasite of man in Russia, Switzerland, North America, and Japan, results from eating diseased fish, especially pike, which have not been sufficiently cooked. All these three forms attain their adult state in the human intestine, from which they can be expelled with comparative ease by suitable drugs. Another tape-worm (*Tænia echinococcus*) which when adult is found in the dog's intestine, is a much more dangerous parasite to man, in whom it may occur in its earlier bladder-worm form of existence as a swelling or cyst in the lungs or liver (*Echinococcus veterinorum*, fig. 1240), often with fatal consequences.

Pigs and ruminants are also liable to the disease. Gamble says of the bladder-worm stage (in *The Cambridge Natural History*):—"*Echinococcus* is most frequent in Iceland, where it affects 2 to 3 per cent of the population, and a still larger proportion of sheep; while in Copenhagen, Northern Germany, some districts of Switzerland, and Victoria it is not uncommon, but is frequently found during *post-mortem* examinations when no definite symptoms of its presence had been previously noticed."

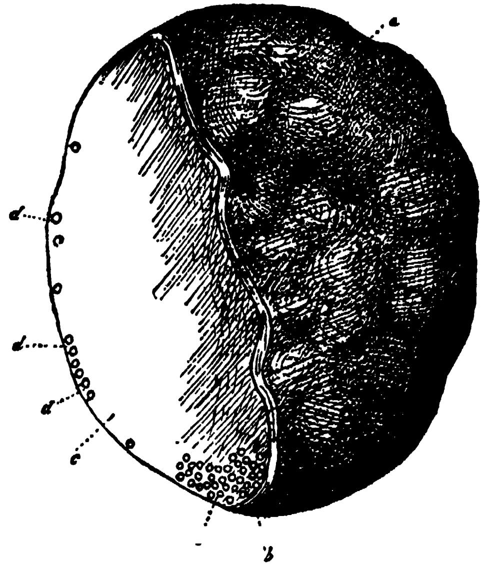


Fig. 1240.—Echinococcus Cyst from the Liver of a Cow

a, Outer covering of cyst, which has been cut away along *b* to show the cyst itself (*c*); *d, d, d*, secondary cysts each of which may produce several tape-worms. Reduced.

PERSONAL ENEMIES AMONG ROUND-WORMS (NEMATHELMIA).—A number of species of these objectionable forms are found as internal parasites within the bodies of human beings. The Round-Worm (*Ascaris lumbricoides*) and Thread-Worm (*Oxyuris vermicularis*) are two of the commonest sorts. Far more dangerous than these is one of the Palisade-Worms (*Dochmius duodenalis*), which possesses spines in the neighbourhood of the mouth, enabling it to burrow in the wall of the small intestine of its host. This worm is the cause of the fatal disease called "miners' anæmia".

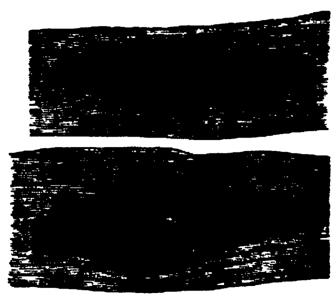


Fig. 1241.—Trichinæ encysted in Muscle. Much enlarged

The Guinea-Worm (*Filaria medinensis*), only too well known in tropical countries, is the cause of serious tumours, especially in the legs. These are caused by the female, an elongated (usually 20 to 32 inches) slender creature which lives under the skin of the person affected.

Trichinosis is an extremely dangerous disorder contracted by eating diseased pork, containing the encapsuled stage of a minute

thread-worm (*Trichina spiralis*, fig. 1241). On reaching the human stomach the capsules are dissolved, the minute worms become adult, and myriads of larvæ are produced, which bore into the walls of the intestine. They are then carried in the blood to different parts of the body, especially the muscles, where they come to rest, and pass into the encapsuled stage. Pigs contract the complaint by eating diseased rats, or the offal from their slaughtered fellows, if the latter are infected.

PERSONAL ENEMIES AMONG HEDGEHOG-SKINNED ANIMALS (ECHINODERMATA).—Unpleasant wounds may be given by the long sharp spines of some sea-urchins, especially when these are provided with poison-glands (see vol. ii, p. 361).

PERSONAL ENEMIES AMONG ZOOPHYTES (CŒLENTERATA).—The larger Jelly-Fishes, such as the Portuguese Man-of-war (*Physalia*), possess innumerable nettling capsules, by which they can inflict painful stings, of which the effects may long be felt.

PERSONAL ENEMIES AMONG ANIMALCULES (PROTOZOA).—These are probably more numerous than at one time suspected. The malaria-parasites introduced by means of Mosquitoes (see p. 341) are the most serious at present known.

CHAPTER LXXI

ANIMAL FOES—FORMS INJURIOUS TO HUMAN INDUSTRIES

A large volume would be required to give anything like an adequate account of the innumerable animal pests which more or less diminish the success of many human operations. Keepers of stock or poultry, crop-growers, gardeners, foresters, and the like, all have constant and painful experience of some such forms. Other animals damage buildings, food, clothes, and various manufactured articles. To cope successfully with many of these foes requires much knowledge of their habits and life-histories, and such knowledge can only be acquired by patient and long-continued scientific research, carried out by trained experts. Although an increasing amount of this kind of work is done in the United Kingdom, we are at present very far behind such countries as Germany and the United States, where the value of research is fully appreciated by the authorities. Our own government is comparatively apathetic in the matter, and our universities are too much occupied in turning out graduates by the score to undertake more than a small fraction of the original investigations upon which the prosperity of many of our industries ultimately depends.

It is only possible here to briefly review the animal kingdom with a view to pointing out some of the more injurious forms.

INJURIOUS MAMMALS (MAMMALIA).—It goes without saying that the carnivores which attack man (see p. 331) are still more mischievous by way of raiding flocks and herds. Besides which, members of the same group which are not powerful enough to be considered our own personal enemies, may nevertheless be very destructive to domesticated animals. Foxes, Weasels, and Stoats may be mentioned in illustration. But at the same time it ought to be remembered that the damage inflicted is not

infrequently balanced, or even outweighed, by benefits conferred in other ways (see p. 325).

Cultivated plants are often injured or destroyed by herbivorous or omnivorous Mammals—Deer and various gnawing mammals, such as Rats, Mice, Voles, Hares, and Rabbits. Such creatures may also be injurious in gardens, orchards, and woods, by injuring the bark of trees. In this respect Goats are particularly destructive. A remarkable instance of this is given in the following passage from Wallace (*Island Life*):—"When first discovered [over 400 years ago], St. Helena was densely covered with a luxuriant forest vegetation, the trees overhanging the seaward precipices and covering every part of the surface with an evergreen mantle. This indigenous vegetation has been almost wholly destroyed; and although an immense number of foreign plants have been introduced, and have more or less completely established themselves, yet the general aspect of the island is now so barren and forbidding, that some persons find it difficult to believe that it was once all green and fertile. The cause of the change is, however, very easily explained. The rich soil formed by deçomposed volcanic rock and vegetable deposits could only be retained on the steep slopes so long as it was

Fig. 1242.—Common House-Mouse (*Mus musculus*)

protected by the vegetation to which it in great part owed its origin. When this was destroyed, the heavy tropical rains soon washed away the soil, and has left a vast expanse of bare rock or sterile clay. This irreparable destruction was caused in the first place by goats, which were introduced by the Portuguese in 1513, and increased so rapidly that in 1588 they existed in thousands. These animals are the greatest of all foes to trees, because they eat off the young seedlings, and thus prevent the natural restoration of the forest. They were, however, aided by the reckless waste of man."

Rats, Mice (fig. 1242), and other small rodents are destructive to stored grain and other commodities, and may become a thorough nuisance in dwellings, as most of us have found by experience. Such creatures may also be productive of serious harm by disseminating various diseases. Rats, for example, often cause trichinosis in swine (see p. 344), and hence indirectly in human beings, or may spread such virulent germs as those of bubonic plague.

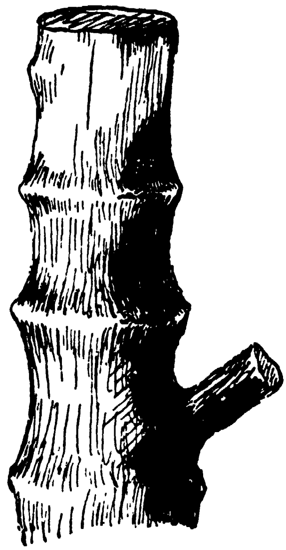


Fig. 1243.—Tree "ringed" by a Woodpecker

INJURIOUS BIRDS (AVES).—Large birds of prey, such as Eagles, may attack various domesticated animals, and even the Raven (*Corvus corax*) is known to injure lambs, among other forms. The Kea Parrot (*Nestor notabilis*) of New Zealand has acquired the reprehensible habit of killing sheep by biting deep holes in their backs, its object being said to be to reach the fat in the neighbourhood of the kidneys. The smaller Birds of Prey may raid poultry-yards or game-preserves, and some of them destroy useful insectivorous birds. Certain species, however, do more good than harm (see p. 327).

Among insectivorous birds the Woodpeckers damage trees in the course of their search for food (fig. 1243), and also sometimes by excavating nesting-holes in sound trunks. A great many plant-eating or omnivorous birds do much mischief in cultivated fields, gardens, and orchards, the exact nature of the depredations depending upon the species. Most, if not all, omnivorous birds also do a certain amount of good, sufficient, in some cases, en-

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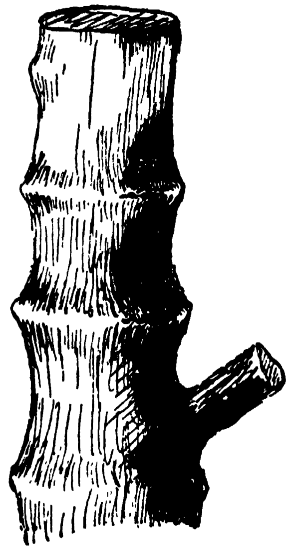

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tirely to outweigh their misdeeds. Crows, Rooks, and Sparrows are among the most hurtful forms in Western Europe. Some of the mainly beneficial species are: Thrushes, Starlings, and Chaffinches.

INJURIOUS REPTILES (REPTILIA).—It is only necessary to note that Crocodiles, Alligators, and poisonous Snakes destroy a number of domesticated animals.

INJURIOUS FISHES (PISCES).—Some of the more voracious freshwater forms, especially the Pike (*Esox lucius*) destroy other species of greater value, or interfere with the work of fish-culture. Skate and Rays are destructive to oysters.

INJURIOUS MOLLUSCS (MOLLUSCA).—Forms like the Octopus and its kind destroy oysters, as also do several species of boring sea-snail. Of the latter the "whelks" detrimental to British oyster-culture are chiefly the Common Whelk (*Buccinum undatum*), the Dog-Whelk (*Nassa reticosa*), and the Purple-Shell (*Purpura lapillus*). Various North American species which do harm in the same way are popularly known as "drills".

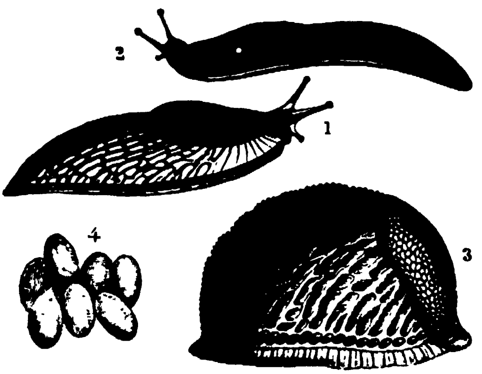

Fig 1244.—1, Field-Slug (*Limax agrestis*), 2, Black Slug (*Arion ater*); and 3, a related species (*A. empiricorum*) with its eggs 4.

Cultivated plants of almost all kinds are liable to the attacks of various Land-Snails and Land-Slugs (fig. 1244), which are probably by far the most injurious of all molluscs from the human stand-point.

Among injurious bivalves the Ship-Worm (*Teredo navalis*) is notorious for the way in which it has damaged the timbers of ships and wooden piles. At one time it worked such devastation in the sea-dykes of Holland that serious disaster was threatened. The Edible Mussel (*Mytilus edulis*) is sometimes an enemy to oyster-culture, as it may cover up and smother beds of young oysters.

INJURIOUS INSECTS (INSECTA).—These are so excessively numerous, and at the same time so destructive, that they are the subject of a particularly extensive literature, and constantly engage the attention of many skilled naturalists, especially at the numerous experimental Entomological Stations of America.

Domesticated animals are attacked by a great variety of insects, of which only a few can be here mentioned. Something has elsewhere been said about Bot-Flies (see p. 191). Two such forms, the Ox-Warble Flies (*Hypoderma bovis* and *H. lineatus*, fig. 1245), lay their eggs on the legs of cattle, usually near the heels. It is probable (but not absolutely certain) that the maggots when hatched pierce the skin, under which they make their way to the back. At any rate they are found in that region later on, living in swellings ("warbles") which open to the exterior. Of the injuries inflicted Somerville says (in *Farm and Garden Insects*):—"The damage done by this insect is enormous, the Newcastle Hide Protection Society, for instance, reporting that the hides dealt with in that town alone in 1892 had been damaged by warbles to the extent of £14,000. Besides the injury to the leather *H. bovis* causes great damage by unsettling cattle and preventing them thriving properly. When cattle discover that the fly is hovering near they rush wildly about the field; and the constant irritation to which the larva subjects them when located in the skin is no less detrimental to the animals. The flesh in the neighbourhood of the warbles is also much reduced in value, being covered by a jelly-like substance known as 'licked beef'."

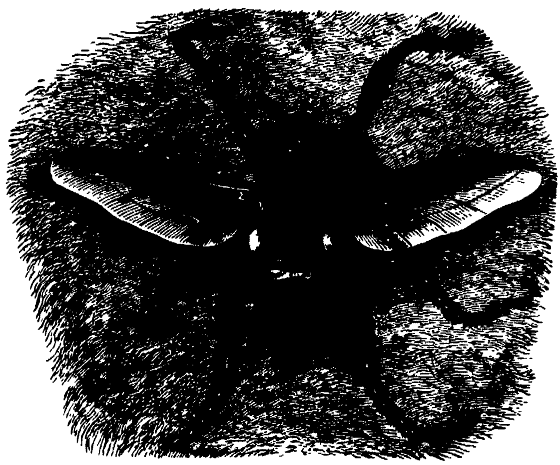
Fig. 1245—Ox-Warble Fly (*Hypoderma*), enlarged

The bite of the much-dreaded Tsetse Fly (*Glossina morsitans*) of tropical Africa is fatal to horses, producing "nagana" or "fly-sickness" (see p. 241). This is because the bite introduces into the horse's blood certain stages in the life-history of a parasitic animalcule (*Trypanosoma*), which attacks the red corpuscles. Other biting flies may introduce fatal germs, as, *e.g.*, the bacilli which are the cause of anthrax (splenic fever, quarter evil).

The insect pests which damage stock are mostly Flies and

Fleas (*Diptera*), but forms extremely injurious to cultivated and other plants are to be found in several orders, as a brief summary will show. It will be convenient to mention at the same time some of the species which damage food, clothing, buildings, &c. &c.

Bugs (*Hemiptera*).—By means of their piercing and suctorial mouth-parts innumerable members of this order are able to feed upon the sap of plants, often with the most deplorable consequences. Aphides or Green-Flies (*Aphidæ*) and Scale-Insects or Mealy Bugs (*Coccidæ*) are among the most mischievous, for though of small size they are astoundingly prolific.

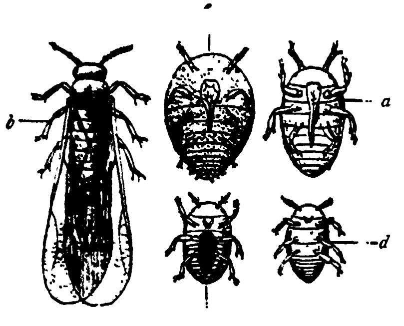

Fig 1246 —Vine Aphis (*Phylloxera vastatrix*)

a, Wingless root-sucking female; *b*, winged overground female; *c*, wingless overground female; *d*, male; *e*, gall-producing female.

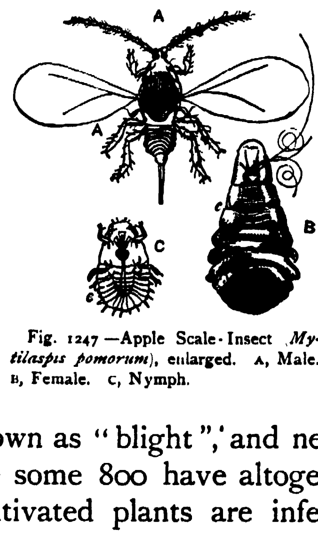

Fig. 1247 —Apple Scale-Insect (*Mytilaspis pomorum*), enlarged. A, Male. B, Female. C, Nymph.

Aphides are often popularly known as "blight", and nearly 200 species of them are British, while some 800 have altogether been described. Many important cultivated plants are infested by particular kinds of Aphis, as will be gathered from the names of the following:—Corn Aphis (*Aphis cerealis*), Oat Aphis (*A. avenæ*), Bean Aphis (*A. fabæ*), Cabbage Aphis (*A. brassicæ*), Turnip Aphis (*A. rapæ*), Hop Aphis (*A. humuli*), Cherry Aphis (*A. cerasi*), Plum Aphis (*A. pruni*), &c. &c. Enormous damage is done in vineyards by the Vine Aphis (*Phylloxera devastatrix*, fig. 1246). During the spring and summer wingless females work havoc upon the roots, which swell up into small galls. They lay unfertilized eggs, which hatch out into forms like themselves, and there may be as many as eight generations of the kind produced during the season. But the last batch of these eggs produced in autumn gives rise to wingless males and winged females, that live above-ground and attack the leaves. The fertilized "winter-

eggs" of this generation survive, lie dormant during the winter, and wingless females hatch out from them in the following spring.

Scale-Insects (*Coccidæ*), of which one kind has already been described (see vol. iii, p. 381), are particularly harmful in fruit-culture. Well known in Britain are—Apple Scale (*Mytilaspis pomorum*), white woolly Currant Scale (*Pulvinaria ribesiæ*), and Gooseberry and Currant Scale (*Lecanium ribis*).

Fringe-Winged Insects (*Thysanoptera*). See vol. i, p. 355.

Flies (*Diptera*).—The most familiar pests belonging to this group are the Crane-Flies or "Daddy-Long-Legs" (*Tipulidæ*), of which there are at least some thirty British species. The larvæ, known as "leather-jackets", are very destructive to the roots of grasses and cereals (fig. 1248). A species which has been responsible for great damage to cereal crops in America is the Hessian Fly (*Cecidomyia destructor*), so called because it is supposed to have been introduced into the New World in 1778 by means of straw brought by Hessian mercenaries. The female fly lays her eggs in pairs in the angles where the leaves of wheat, barley, or rye join the stem. The maggots feed upon the juices of the haulm, causing this to bend or break, and interfering greatly with the development of the grain. The Wheat-Midge (*Cecidomyia tritici*) is chiefly destructive to wheat and rye, the eggs in this case being laid in the flowers. The Frit-Fly (*Oscinis frit*) is injurious to cereals in much the same way as the Hessian Fly, but its eggs are here laid on the under sides of the leaves. Some flies lay their eggs on food, and cause great annoyance. The Blow-Fly or Blue-Bottle (*Musca vomitoria*) and the Cheese-Fly (*Piophila casei*) are well-known examples.

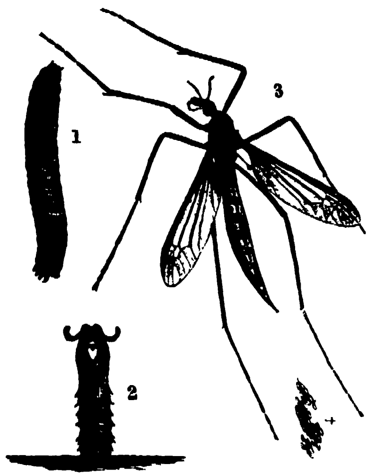

Fig. 1248.—Crane-Fly (*Tipula oleracea*). 1, Larva; 2, pupa; 3, adult; 4, eggs.

Moths and Butterflies (*Lepidoptera*).—Almost everyone has noticed the way in which the caterpillars of these insects voraciously devour plants of various kind, and a mere list of destructive species would occupy a considerable space. Among injurious

Butterflies the Whites (*Pieridæ*) are only too familiar. They include, for example, the Large Garden White or Cabbage Butterfly (*Pieris brassicæ*), the Small White (*P. rapæ*), and the Green-veined White (*P. napi*). The leaves of cabbages, cauliflowers, turnips, and other cruciferous plants are ravaged by the insatiable caterpillars.

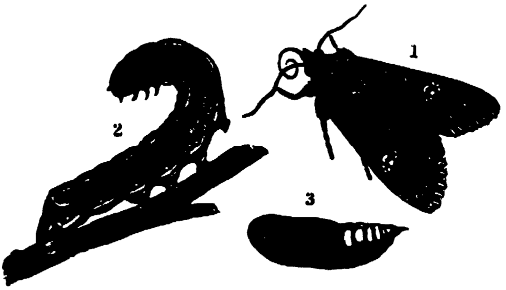

Fig 1249.—Cabbage Moth (*Mamestra brassicæ*). 1, Adult female, 2, larva, 3, pupa.

The larvæ of many species of Owlet Moths (*Noctuidæ*), under the name of "surface caterpillars", are responsible for a large amount of damage to various cultivated plants. Notable forms are the Turnip Moth (*Agrotis segetum*), Heart-and-Dart Moth (*A. exclamationis*), and Great Yellow Underwing (*Triphæna pronuba*).

Among other species of which the larvæ are destructive to ordinary crops may be mentioned—Silver-Y Moth (*Plusia gamma*), inimical to most cultivated herbs; Cabbage Moth (*Mamestra brassicæ*, fig. 1249); Pea Moth (*Grapholitha nebritana*), the caterpillars of which penetrate the young pods and feed on the immature peas; Grass Moth (*Charæas graminis*), a


Fig. 1250.—Codlin Moth (*Carpocapsa pomonella*). Adult female on left, larva in centre, pupa to right (its actual size indicated by a line).

pasture pest; and Diamond-back Moth (*Plutella cruciferarum*), destructive to various crucifers.

Various trees of economic importance are liable to be attacked by voracious caterpillars. What are known as "worm-eaten" apples, for instance, commonly owe their condition to the larvæ of the Codlin Moth (*Carpocapsa pomonella*, fig. 1250). The large caterpillars of the Goat Moth (*Cossus ligniperda*) bore great holes in forest-trees, while the larvæ of other species ravage their

foliage. The Nun (*Psilura monacha*) is a very serious forest pest in Germany, for its caterpillars devour pine-needles and the leaves of hardwood trees in a wholesale manner. The Gipsy Moth (*Ocneria dispar*), introduced from Europe into the United States some thirty years ago, has within the last decade proved a veritable scourge to many trees. Fletcher Osgood makes the following observations about this particular pest (in *Harper's Magazine*, 1897):—"The careful reckoning of science has demonstrated that the unrestricted caterpillar increase of a single pair of gipsy moths would suffice in eight years to devour the entire vegetation of the United States. In the ordinary course of nature (let Heaven be thanked for it!) such increase is never left wholly unrestricted. . . . Since the work [of extermination] began [in Massachusetts], some forty-two millions of trees have been inspected, while the number of the buildings, walls, and fences thus looked over exceeds four hundred thousand. Besides myriads of the gipsy kind destroyed by burning and in other ways, and hosts escaping record in the first years of the outbreak, the force employed against the caterpillar has killed directly by hand, to date, about two billions and three millions of these dreadful creatures. The unrecorded destruction will doubtless bring the list of killed to at least some four billions. The results so far have more than justified the necessary outlay."

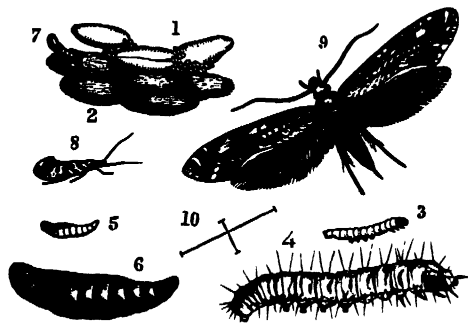

FIG 1251.—Corn Moth (*Tinea granella*). 1, Infested grains held together by threads of silk; 2, cocoons; 3, larva; 4, the same enlarged; 5, chrysalis; 6, the same, enlarged; 7, empty chrysalis skin projecting from cocoon; 8, adult female; 9, the same, enlarged (actual size in same position indicated at 10).

The Corn Moth or Corn Wolf (*Tinea granella*, fig. 1251) is a small granary-pest that does much damage to stored grain. The Clothes-Moths, so destructive to garments of cloth and fur, are closely related.

The last species to be here mentioned is the Wax Moth (*Galleria mellonella*), one of the enemies of apiculturalists. The female tries to enter a bee-hive, and, if successful, lays her eggs there. When the caterpillars hatch out they burrow into the combs, and feed upon the wax.

Injurious Beetles (*Coleoptera*).—Many notorious malefactors belong to this order. Among the most injurious are "wire-worms", which do great damage to the underground parts of cereals, grasses, and root-crops, and are no other than the larvæ of the little Click-Beetles (*Elateridæ*). The still smaller Turnip Flea-Beetles (*Haltica nemorum*, fig. 1252, and *H. undulata*), popularly known as Turnip-"Flies", are very injurious to turnips and related plants, for the adults attack the leaves from the outside, while their larvæ burrow within them. Some of the "Chafers" are very injurious to trees, crops, and pastures. The Common Cockchafer (*Melolontha vulgaris*), when adult, ravages the foliage of trees, while its grubs live underground, and attack the roots of grasses, various crop-plants, and many trees. A form which created a "scare" in this country some years ago is the Colorado Beetle (*Chrysomela decemlineata*), a particularly prolific insect which, both in the larval state and when adult, devours potato leaves.

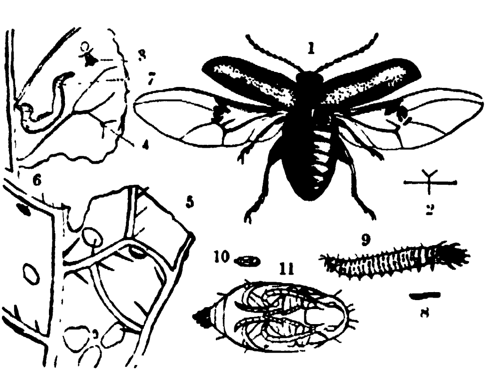

Fig. 1252.—Stages of Turnip Flea-Beetle (*Haltica nemorum*). 1, Adult (enlarged), showing wing-covers and wings spread out; 2, 3, natural size of same; 4, 5, eggs (5 enlarged); 6, 7, burrows of larvæ (7 enlarged); 8, 9, larva (natural size and enlarged); 10, 11, pupa (natural size and enlarged).

The larvæ of Beetles belonging to one family (*Bruchidæ*) burrow in seeds, and some of them infest plants of economic value, *e.g.* Pea-Beetles (*Bruchus pisi*) and Bean-Beetle (*B. fabæ*).

The little long-snouted Weevils (*Curculionidæ*), of which something like 20,000 species have already been described, include a large number of pests, of which both adults and larvæ feed on vegetable matter. The Pea-Weevil (*Sitones lineatus*), for example, devours the leaves of pea, bean, clover, &c., while its larvæ prey upon their roots. The Apple-blossom Weevil (*Anthonomus pomorum*) is very destructive in orchards to both apple and pear. The female insect deposits her eggs in the young flower-buds, one in each, and may carry on this injurious operation for two or three weeks. The Corn-Weevil (*Calandria granaria*, fig. 1253) bores holes in young grains of corn, and each of the some 150 eggs of a single female are deposited within separate grains. Some of

the Weevils are among the pests of forestry, certain forms attacking conifers, *e.g.* species of *Hylobius* and *Pissodes.*

Some of the Beetles are indoor pests, their larvæ feeding on all sorts of substances. The members of one small family (*Dermestidæ*) devour animal substances, and are very destructive in museums. To one species at least (*Anthrenus fasciatus*) the horse-hair coverings of furniture prove palatable. The larvæ of the Bacon-Beetle (*Dermestes lardarius*) indulge in a more luxurious diet, as the name indicates. The larvæ and adults of certain species belonging to another family (*Ptinidæ*) are not often seen, though some of them are frequently heard, and their "works" are familiar. A kind of literary flavour attaches itself to the Biscuit-"Weevil" (*Anobium paniceum*), for its larva is most likely the "original bookworm" which finds its pabulum in libraries, though paper is not the only item in its bill of fare, for Sharp remarks (in *The Cambridge Natural History*) that ". . . it must possess extraordinary powers of digestion, as we have known it to pass several consecutive generations on a diet of opium; it has also been reported to thrive on tablets of dried compressed meat; in India it is said to disintegrate books; a more usual food of the insect is, however, hard biscuits; weevily biscuits are known to every sailor, and the so-called 'weevil' is usually the larva of *A. paniceum*". The "Greater Death-Watches" belong to allied species (*A. striatum* and *A. tessellatum*), and are the cause of "worm-eaten" wood and much superstition.

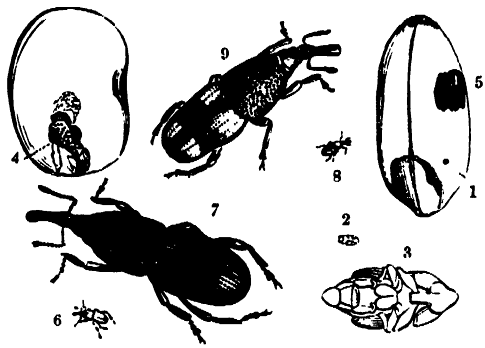

Fig. 1253.—Weevils. 1, Grain of wheat, showing the punctured hole; and 5, the exit of the perfect weevil. 2. Pupa (natural size); 3, magnified. 4, Grain of Indian corn, with weevil inside. 6, 7, Corn-Weevil (*Calandra granaria*), natural size and magnified; 8, 9, Rice-Weevil (*C. oryzæ*), natural size and magnified.

Injurious Membrane-Winged Insects (*Hymenoptera*).—To farmers and fruit-growers the Saw-Flies are here most deleterious, while Wood-Borers are among the pests of forestry. Their operations have been already sufficiently described (see vol. i, p. 371; vol. ii, p. 203; and vol. iii, p. 386). Prominent pests are the Corn Saw-Fly (*Cephus pygmæus*), Turnip Saw-Fly

(*Athalia spinarum*), Apple Saw-Fly (*Hoplocampa testudinea*), Gooseberry and Currant Saw-Fly (*Nematus ribesii*), Cherry and Pear Saw-Fly (*Eriocampa limacina*), Plum Saw-Fly (*Hoplocampa fulvicornis*), and Pine Saw-Fly (*Lophyrus pini*, fig. 1254).

Other net-winged insects may at times be injurious, *e.g.* Wasps sometimes damage large quantities of fruits, while Ants make raids on provisions (especially those containing sugar), and Carpenter-Bees (*Xylocopa*) destroy woodwork.

Injurious Net-winged Insects (*Neuroptera*).—The Biting-Lice (*Mallophaga*) live as ectoparasites on birds or mammals, and feed on their feathers or hairs, at the same time causing much irritation. Domestic fowls are pestered by no less than five species of these insects, one (*Menopon pallidum*) being particularly common. The

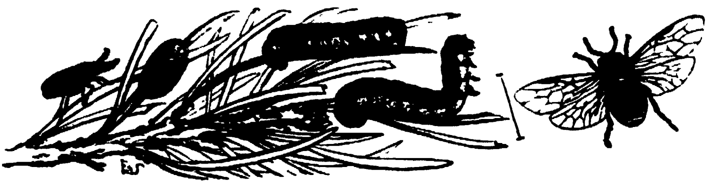

Fig 1254.—Pine Saw-Fly (*Lophyrus pini*) On the branch to the left are two larvæ, a cocoon, and an adult male: on the right is an adult female, enlarged actual size indicated by the line).

Biting Dog-Louse (*Trichodectes latus*) not only torments its host, but also harbours a stage in the life-history of a tape-worm which lives when adult in the dog's intestine.

In some of the hotter countries of the world Termites or "White Ants" are very harmful to furniture and woodwork, on account of their habit of excavating and feeding upon wood (see p. 120). An interesting example is giving by Sharp (in *The Cambridge Natural History*), who says:—"A Termite (*Termes tenuis*) was introduced—in what manner is not certainly known—to the island of St. Helena, and committed such extensive ravages there that Jamestown, the capital, was practically destroyed, and new buildings had to be erected".

Injurious Straight-winged Insects (*Orthoptera*).—Locusts have been one of the scourges of mankind from the earliest times, owing to their enormous fertility and the wholesale manner in which they devour all sorts of vegetation (see vol. i, p. 382, and vol. iii, p. 379). The species which migrate from place to place in vast swarms, are those which do most mischief. The following quotation from Sharp (in *The Cambridge Natural History*)

regarding such forms will give an idea of the possibilities:—"In countries that are liable to their visitations they have a great influence on the prosperity of the inhabitants, for they appear suddenly on a spot in huge swarms, which, in the space of a few hours, clear off all the vegetable food that can be eaten, leaving no green thing for beast or man. It is difficult for those who have not witnessed a serious invasion to realize the magnitude of the event. Large swarms consist of an almost incalculable number of individuals. A writer in *Nature* [Carruthers, 1889] states that a flight of locusts that passed over the Red Sea

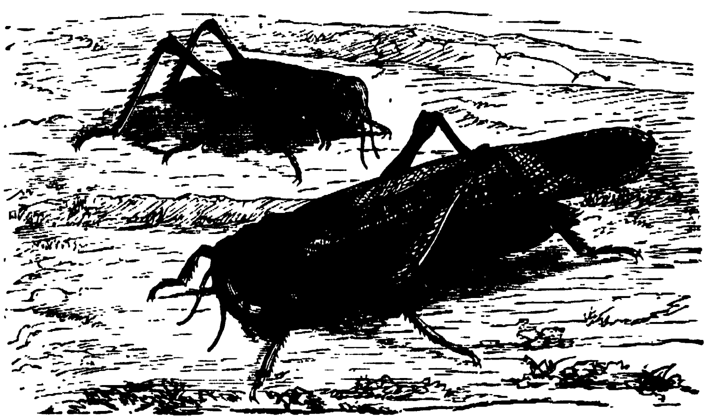

Fig 1255 —Larva and Adult Female of the Migratory Locust (*Schistocerca peregrina*)

in 1889 was 2000 square miles in extent, and he estimated its weight at 42,850 millions of tons, each locust weighing $\frac{1}{16}$ of an ounce. A second similar, perhaps even larger, flight was seen passing in the same direction the next day. That such an estimate may be no exaggeration is rendered probable by other testimony. From official accounts of locusts in Cyprus we find that in 1881, up to the end of October, 1,600,000,000 egg-cases had been that season collected and destroyed, each case containing a considerable number of eggs. By the end of the season the weight of the eggs collected and made away with amounted to over 1300 tons, and, notwithstanding this, no less than 5,076,000,000 egg-cases were, it is believed, deposited in the island in 1883. When we realize the enormous number of individuals of which a large swarm of locusts may consist we can see that famine is only a too probable sequence, and that pestilence may follow—as it often has done—from the decomposition of the

bodies of the dead insects. This latter result is said to have occurred on some occasions from locusts flying in a mass into the sea, and their dead bodies being afterwards washed ashore."

Of other well-known members of the present order which are to be regarded as pests may be mentioned: The Earwig (*Forficula auricularia*), which attacks flowers and fruits; Cockroaches (our common species is *Periplaneta orientalis*), that are troublesome in houses and on board ships; and the Mole-Cricket (*Gryllotalpa vulgaris*), which is injurious to pasture.

Principles regulating the Methods employed in Combating Injurious Insects.—These are summarized by Ritzema Bos (in *Tierische Schädlinge und Nützlinge*) under (1) Preventive Measures, (2) Curative Measures, (3) Measures which are both Preventive and Curative. It may be well once more to emphasize the fact that to successfully combat harmful insects (and all other pests) an intimate knowledge of their habits and life-histories is essential. There is commonly, for example, some stage in the development of a particular animal which can be exterminated with comparative ease and at relatively small expense. This must be carefully borne in mind, or it may turn out that, financially speaking, "the remedy is worse than the disease".

(1.) *Preventive Measures.*—Sickly plants are in many cases more subject to infestation than healthy ones, and it therefore follows that all the means adopted by farmers, gardeners, and foresters to promote the vigour of the forms with which they are concerned assist in warding off the attacks of injurious insects, &c. It is also well known that seedlings are less able to resist their enemies than plants in a later stage of development, from which it follows that crops should be stimulated to rapid growth at the time when sprouting begins.

One of the benefits to be derived from rotation of crops is to check the ravages of various injurious insects, &c., which only feed upon one or a few kinds of plant. They are often, so to speak, starved out. Clean seed is another important preventive, for without precaution in this direction sowing may mean a distribution of pests as well as plants. And as during part of their existence some noxious forms are harboured in straw, another preventive measure is thereby suggested.

It is also sufficiently obvious that the natural enemies of pests should be protected and encouraged as far as possible. This

particular preventive measure chiefly applies to insectivorous birds and mammals.

(2.) *Curative Measures.*—It is possible to collect and destroy many sorts of pest (see p. 353), although this is usually an expensive matter. The question as to which stage in the life-history of a particular form most readily lends itself to the method is clearly one of great economic importance.

Collection is sometimes facilitated by "luring" pests by means of something which serves to attract them. Slices of potato, for example, have been found to draw large numbers of wire-worms.

Fig. 1256.—Winter-Moth (*Cheimatobia brumata*): male (centre), female (right), and chrysalis (left). The vertical lines indicate actual sizes.

Many creatures can be destroyed in the places where they live by means of certain powders and sprays, distributed by various ingenious appliances. Soot, quick-lime, "Paris green" (an aceto-arsenite of copper), soap-suds, paraffin emulsion, &c. &c., all have their special uses.

(3.) *Measures which are both Preventive and Curative.*—These may be illustrated by "tar-rings", employed in combating the Winter-Moth (*Cheimatobia brumata*, fig. 1256), destructive to fruit-trees, and the Gipsy-Moth (*Ocneria dispar*), which is an enemy to all sorts of trees. In both these species the dormant chrysalis stage is passed through in the ground. As the wings of the female Winter-Moth are small and useless, while the female Gipsy-Moth cannot (or at any rate does not) fly, both of them have to creep up the tree-trunks in order to lay their eggs. This can be prevented by means of a tar-coated band of suitable material fixed round the trees a short distance above the ground. Collection and destruction of moths and eggs naturally follow.

Injurious Spider-like Animals (Arachnida).—The only forms of great importance here are the Mites (*Acarina*). Mange- and Itch-Mites, injurious to domesticated animals, have already been mentioned (see p. 196). Poultry are attacked as well as quadrupeds. Fowls are also liable to be infested by Red Fowl-Mites (*Dermanyssus gallinæ*), which suck their blood and set up an intolerable itching.

Domesticated animals are also often attacked by Ticks (*Ixodidæ*), which are able to draw large quantities of blood, and, what is more serious, may convey the germs of disease. Infection by means of one such Tick (*Ixodes reduvius*) is, for example, the cause of "louping ill" in sheep.

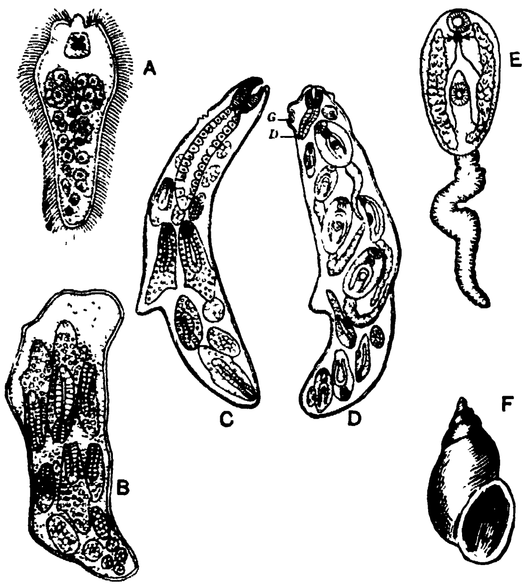

Fig 1257.—Stages in Life-History of Liver-Fluke (*Fasciola hepatica*, enlarged A, ciliated larva; B, sporocyst, within which rediæ are developing; C, redia, within which a new generation of rediæ is developing; D, redia, with contained cercariæ (*G*, opening by which these escape, *D*, intestine); E, cercaria. B to E are parasitic within the water-snail F *Limnæa truncatula*), from which E escapes to encyst on the stem of a plant.

Cultivated plants also suffer from the attacks of Mites, among which the following may be mentioned:—Currant Gall-Mite (*Phytoptus ribis*), Red Hop-"Spider" (*Tetranychus telarius*), Red Plum-"Spider" (*T. rubescens*), and Harvest or Gooseberry-"Bug" (*T. autumnalis*).

Other kinds of Mite spoil furniture and attack food, especially meal, cheese, and sugar.

Injurious Myriapods (Myriapoda).—Some of the Millipedes ("false wire-worms") attack the underground parts of various plants, or may damage soft fruits.

Injurious Flat-Worms (Platyhelmia).—A large number of Flukes (Trematoda) and Tape-Worms (Cestoda) are parasitic within the bodies of domestic animals, as previously stated in dealing with the personal enemies of man (see p. 342). A few details may be appropriately added.

Flukes (*Trematoda*).—It is only necessary here to refer to the

Liver-Fluke (*Fasciola hepatica*, fig. 1257), a brief account of which has already been given (see vol. i, p. 443). The adult Fluke is parasitic in the liver of the sheep, causing the serious disease known as "liver-rot", while certain earlier stages of the life-history are passed within a small water-snail (*Limnæa truncatula*). The following extract from Gamble (in *The Cambridge Natural History*) will give some idea of the serious losses which may be caused by this destructive parasite:—"Over the whole of Europe, Northern Asia, Abyssinia, and North Africa, the Canaries, and the Faroes the fluke and the snail are known to occur, and recently the former has been found in Australia and the Sandwich Islands, where a snail, apparently a variety of *Limnæa truncatula*, is also found. Over these vast areas, however, the disease usually only occurs in certain marshy districts and at certain times of the year. Meadows of a clayey soil, liable to be flooded (as in certain parts of Oxfordshire), are the places where this *Limnæa* occurs most abundantly, and these are consequently the most dangerous feeding-grounds for sheep. The wet years 1816, 1817, 1830, 1853, and 1854—memorable for the occurrence of acute liver-rot in England, Germany, and France—showed that the weather also plays a considerable part in extending the suitable ground for *Limnæa* over wide areas which in dry years may be safe pastures. In 1830 England lost from this cause one and a half million sheep, representing some four millions of money, while in 1879–80 three millions died. In 1862 Ireland lost 60 per cent of the flocks, and in 1882 vast numbers of sheep perished in Buenos Ayres from this cause. In the United Kingdom the annual loss was formerly estimated at a million animals, but is now probably considerably less." This extract clearly shows the importance of scientific research to agriculture, as preventive measures clearly depend upon an accurate knowledge of the life-history of the fluke.

Tape-Worms (*Cestoda*).—The disease of sheep known as "staggers" or "sturdy" is due to the presence of large cysts that cause pressure on the brain, and are the bladder-worm stage (*Cœnurus cerebralis*) of a Tape-Worm (*Tænia cœnurus*) that lives when adult in the intestine of a sheep-dog (fig. 1258). A sheep contracts the disease by swallowing eggs of the parasite which have passed out of the body of a dog, while in its turn a dog becomes infected if it devours cysts from the brain of a sheep that has died of staggers.

Dog and Rabbit (or Hare) are the two hosts of another kind of Tape-Worm (*Tænia serrata*), of which the adult lives in the intestine of the former animal, while the bladder-worm stage (*Cysticercus pisiformis*) is harboured in the body of the latter.

INJURIOUS THREAD-WORMS (NEMATHELMIA).—Many of the worms belonging to this group are injurious to domesticated animals and cultivated plants. The large Horse-Worm (*Ascaris megalocephala*), for example, often infests in great numbers the intestine of the horse and its allies, while smaller species of round-worm live as parasites within dogs and cats. Much more dangerous is the minute Trichina (*Trichina spiralis*) that sets up trichinosis in pig and man (see p. 343).

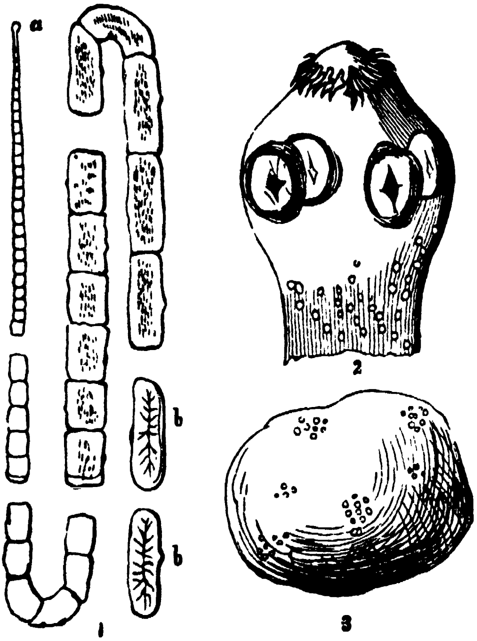

Fig. 1258.—The Tape-Worm (*Tænia cænurus*), of which the cyst causes "staggers" in Sheep. 1, parts of the adult worm (*a*, head; *bb*, ripe joints); 2, head of same (× 30) showing hooks and suckers; 3, cyst from sheep's brain. Several groups of developing tape-worm heads are indicated.

Much harm is caused by the Palisade-Worms or Strongyles (*Strongylidæ*), related to the species which produces "miners' anæmia" in human beings (see p. 343). The Giant-Strongyle (*Eustrongylus gigas*), of which the female may be from a foot to over a yard long, lives in the kidneys of horse, ox, dog, and, it may be, man. Swellings in the arteries of the horse are caused by the presence of Armed Strongyles (*Strongylus armatus*), while other deadly parasites are the Stomach-Strongyle (*S. contortus*) of the sheep, and the Lung-Worm (*S. filaria*) of the lamb. The disease known as "gapes", to which young poultry and game-birds are liable, is caused by the presence of a related species, the Red- or Forked-Worm (*Syngamus trachealis*).

Some of the little Eel-Worms (*Anguillulidæ*) are serious agricultural pests. They possess a spine at the front end of the body, by which they bore into the tissues of plants. One species, the Wheat Eel-Worm (*Tylenchus scandens*), has been described in

an earlier section (see vol. ii, p. 222). The Stem Eel-Worm (*T. devastatrix*) attacks the stems and leaves of rye, oats, buckwheat, clover, &c., leading to stunted growth, or even killing the plants outright. "Clover sickness" is set up by the presence of this parasite. The Beet Eel-Worm (*Heterodera Schachtii*, fig. 1259) infests the roots of its host-plant, and causes "beet sickness". The related Root-knot Eel-Worm (*H. radicicola*) produces galls on the roots of clover, lucerne, cucumber, tomato, and many other cultivated plants.

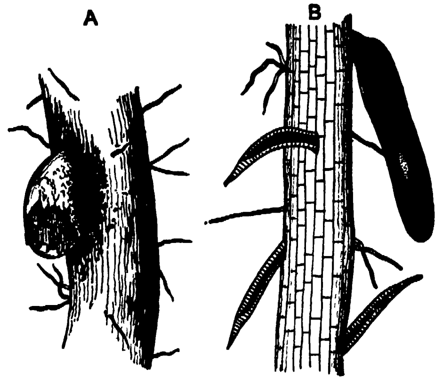

Fig. 1259.—Roots of Beet, infested by Beet Eel-Worm (*Heterodera Schachtii*), enlarged. A shows a swelling containing adult female; B, larvæ attacking a root.

INJURIOUS ANIMALCULES (PROTOZOA).—Nagana or "fly-sickness" (see p. 241) is the best example of disease resulting from the presence of parasitic animalcules in the bodies of domesticated animals.

Some ailments of cultivated plants are also the result of the attacks of certain Protozoa. One instance is afforded by "finger-and-toe" or "anbury", a turnip disease associated with curious deformation of the roots. It is due to the presence of one of the Fungus-Animals (Mycetozoa) within the tissues (i.e. *Plasmodiophora brassicæ*).

CHAPTER LXXII

THE ZOOLOGY OF SPORT

It is hardly necessary to remark that the literature of those forms of "sport" which depend upon the existence of wild animals is very extensive, and includes accounts of experiences and adventures in all parts of the world. Much of it is highly technical, most of it is anecdotal, and but a small part is the work of authors who represent the sportsman and naturalist combined. To name a selection of books for the benefit of expert huntsmen and anglers is of course quite superfluous, but general readers may profitably refer to the following works:—The volumes of *The Badminton Library*, *Fur and Feather Series*, and *The American Sportsman's Library*; Izaak Walton's *Compleat Angler*; Selous' *A Hunter's Wanderings in Africa*; Sir Samuel Baker's *Wild Beasts and their Ways* and *With Rifle and Hound in Ceylon*; *The Big Game of North America*, *English Sport*, *Sport in Europe*, and *The Sports of the World*, edited respectively by G. O. Shields, Alfred E. T. Watson, and (the two last) by F. G. Aflalo.

We have already had occasion to notice (p. 208) that the first stage in the evolution of civilization was represented by the primeval hunter and fisherman, a stage still in evidence to-day among various savage races. But our remote prehistoric ancestors, like modern savages, were "pot-hunters" rather than sportsmen, while the intimate knowledge they must have acquired of the habits of wild animals imparted a certain flavour of the field naturalist. Many primitive races have also had, and some still have, to defend themselves and (in the pastoral and agricultural stages) their domesticated animals from the attacks of predaceous forms. Even when hunting and fishing were necessary for existence, however, a good deal of pleasurable excitement must have attached to the pursuit of wild animals,

rivalry and emulation playing no unimportant part in the matter. When the further evolution of civilization diminished the material importance of hunting and fishing, these arts continued to be pursued for pleasure as well as for profit; hence the origin of modern sport.

This is not the place to enter into a long disquisition regarding the ethics of field-sports, but such of them as deserve the name involve certain obvious fundamentals. There must be room for skill, the quarry must have a fair chance, and every precaution should be taken to prevent a miserable and lingering death on the part of maimed or wounded animals. The hunter of "big game" would no doubt add that "the greater the danger the greater the sport". Selous, for instance, remarks (in *The Sports of the World*):—"Lion-hunting by savages, armed only with spears or bows and arrows, must have been incomparably more dangerous, and therefore infinitely finer sport, than the pursuit of these animals by civilized man at the present day armed with modern rifles". On the other hand, it is quite possible for a recognized form of sport to become so highly artificial as to demand hardly more skill to make a "bag" than would be required to slaughter the inhabitants of the poultry-yard with a shot-gun. Under such circumstances "massacre" and not "sport" would be the proper word to employ.

Our pluck, vigour, and enterprise as a nation are undoubtedly due in no small degree to the influence of field-sports, and to entirely exclude these from our national life, as some would have us do, on the ground of cruelty to animals, would be as inexpedient as it is impossible. On the other hand, the view of the matter which suggests that it is rather a pleasure than otherwise to be hunted may be regarded as a little optimistic. Lady Augusta Fane, for example, makes the following remarks on fox-hunting (in *English Sport*):—"Worthy folks who fancy that they are more humane than their neighbours write about the cruelty of fox-hunting, drawing fancy pictures of a poor, timid, terrified little creature pursued by savage dogs, ruthless viragoes, and brutal men! As a matter of fact, foxes constantly live to a green old age, and defeat their pursuers season after season. They do not even pretend to be frightened. How often we have seen a fox break out of covert, look around, give himself a good shake, and, whisking his brush, trot off without the

slightest sign of fear! He knows where he means to go, and all the safe refuges *en route*; and if he gets tired he is familiar with the woods, where he can find a friend to take his place."

The limited space here available must necessarily be devoted to briefly reviewing the animals which are of importance from the sporting stand-point, including those which assist man in the chase. Mammals, Birds, Reptiles, and Fishes are the only groups with which we are concerned, though the "naturalist" who hunts down insects or the like merely to add to his collection is more of a sportsman (in a very small way) than a man of science; often, however, he is neither!

MAMMALS (MAMMALIA) AS AIDS TO SPORT

It is a natural consequence of the slow rate of human locomotion that several Mammals have been pressed into the service of man in order to make up for this deficiency, or, it may be, reduce the element of danger. From time immemorial, in many sorts of sport, horse and elephant have saved him the work of using his own legs, while dog or falcon have pursued the quarry and tackled it at close quarters.

THE HORSE (EQUUS CABALLUS).—The combination of intelligence and speed by which the horse is characterized, and its susceptibility to thorough domestication, have naturally led to its large employment in the chase. The extraordinary way in which the long-continued influence of man has resulted in the production of widely different breeds of the same kind of animal is here very strikingly exemplified. A well-bred hunter combines to perfection the two desiderata of speed and endurance, and it is, to all intent and purposes, a product of human ingenuity, without which many forms of sport would be comparatively tame and featureless. It may also be remarked in passing, that without highly specialized breeds of horses certain forms of sport which do not depend upon the existence of a quarry, such as horse-racing and trotting, could never have attained their present high pitch of perfection. By the practice of what may almost be called a species of artificial evolution, man has been here able to further his own ends in a remarkable manner.

THE INDIAN ELEPHANT (ELEPHAS INDICUS).—The use of this animal in tiger-shooting is too well known to need description.

It is here not so much a question of speed as of size and strength, by which otherwise impracticable ground can be traversed, while the personal risk of the sportsman is reduced. On the other hand, an element of different kind is introduced by the nervousness and uncertain temper of the elephant, both of which are decidedly in favour of the quarry.

THE DOG (CANIS FAMILIARIS).—The Dog has been the companion of man in the chase from the remotest times, and to all appearance keenly shares in the exhilarating pleasures of pursuit.

Fig 1260.—Pointer

He has proved singularly susceptible to the selective influence of man, practised for unnumbered centuries, the result of which has been the evolution of a very large number of breeds, many of which have been brought into existence for sporting purposes. We know that the ancient Egyptians possessed several breeds of dogs, one of which was a sort of white hound (see p. 222) used in hunting antelopes, for which sport a similar kind of dog is to this day employed in North Africa. They also used packs of mixed character, though the nature of the breeds is doubtful. Upon the Assyrian sculptures we find hunting-mastiffs and greyhounds figured, while inscriptions inform us that still other breeds existed, some of which appear to have been used in sport.

Sporting Dogs (*Canes venatici*) of various kinds were possessed

by the ancient Romans, some hunting by scent (*nare sagaces*), while others, more fleet (*pedibus celeres*), were let slip when the game was in sight.

To enumerate all the existing breeds employed in sport would be both tiresome and unnecessary. The names of many, *e.g.* fox-hound, deer-hound, and otter-hound, to some extent serve as an indication of their character. The exaggeration of natural instincts in artificial directions would appear to have led to the evolution of "pointers" (fig. 1260) and "retrievers". Darwin suggests that the original act of "pointing" was simply the pause which a carnivorous animal often makes before springing upon its prey.

Fig. 1261 —Cheetah (*Cynailurus jubatus*) pursuing an Indian Antelope

It is further interesting to note, that when we employ a pack of hounds to hunt down an animal by scent we are simply making use of the natural methods used by similar forms, when wild, in the pursuit of prey.

THE CHEETAH, OR HUNTING LEOPARD (CYNAILURUS JUBATUS, fig. 1261).—This long-legged animal, which is enabled by its fleetness to capture prey in a more straightforward way than is usual among *felines*, is employed by the native dignitaries of India for coursing antelopes. In former times this variety of sport was practised very largely, and is of ancient origin, having

been known to the Persians so far back as 865 B.C., while at a still earlier period it was familiar to the Assyrians.

THE FERRET.—The slender bodies of the bloodthirsty members of the weasel kind enable them to pursue their prey underground, and advantage is taken of this peculiarity when rabbits are driven from their burrows by means of Ferrets, which are a domesticated variety of the Pole-Cat (*Putorius fœtidus*).

BIRDS (AVES) AS AIDS TO SPORT

Certain Birds of Prey have been employed from very remote times in the pursuit of wild animals, mostly other birds, but the art of Falconry in Europe has steadily declined since firearms came into general use. Another contributing cause has been the gradual increase of the area under cultivation. Lord Granville Gordon (in *Sport in Europe*) thus speaks of the antiquity and wide popularity of this form of sport:—"Records of hawking and falconry are supplied in the writings of Pliny and Aristotle. In Japan, in India, Arabia, Persia, and Syria, we can find it has been practised, and in our own Middle Ages stringent laws were passed referring to it. Hawks and falcons were allotted to men according to their rank and station. An earl had a peregrine, a yeoman a goshawk, a priest a sparrow-hawk, and so on. The king of birds in falconry in our Middle Ages was, and even now is, the peregrine, and the noble game at which to fly this bold and splendid bird was the heron; but I do not think this form of sport is followed any longer in our island." Hawking for rooks or larks is still, however, to be included in the list of British sports.

What may be termed a magnified variety of falconry is practised by the Kirghiz of the Asiatic steppes, the "falcon" in this case being no less noble a bird than the Golden Eagle, while the quarry is often the fox or the wolf (fig. 1262).

MAMMALS (MAMMALIA) HUNTED FOR SPORT

FLESH-EATING MAMMALS (CARNIVORA).—The Lion (*Felis leo*, fig. 1263) is undoubtedly the noblest quarry that falls to the rifle of the sportsman, while the attendant danger and excitement appeal so strongly to those who engage in this form of sport that

also help in the sport, and are more feared by the quarry than one would be apt to imagine. Advantage is also often taken of the fact that the tiger is not a climbing animal to shoot him from a secure station in a tree, a goat or buffalo-calf having been previously tied up within easy range to serve as a "bait". Although justifiable for the destruction of man-eaters, this can hardly be dignified by the name of "sport".

The different species of Bear (*Ursus*) are hunted, and also slaughtered in a variety of ways, but do not take a very high place in the estimation of most sportsmen. In parts of Russia,

Fig. 1264.—Fox (*Canis vulpes*)

for example, Brown Bears (*Ursus arctos*) are considered to be "vermin". The Lapps, however, do not hesitate to attack this animal in its den, a method sufficiently dangerous and exciting to satisfy the most exacting in such matters.

The European Wolf (*Canis lupus*) is the object of more than one form of popular Russian sport. A favourite variety involves the use of fox-hounds and wolf-hounds, the former being employed for drawing the coverts, and the latter for the actual work of coursing. As previously mentioned (p. 369), the Kirghiz practise a species of falconry, of which the wolf is a favourite quarry.

The Fox (*Canis vulpes*, fig. 1264) is familiar to all as the object of one of the most popular, sociable, and exhilarating forms of British sport, but Lord Granville Gordon tells us (in *Sport in Europe*) that "it is doubtful if fox-hunting can long

continue in a congested country like England. Bad agricultural seasons and barbed wire point to its doom." Otter-hunting is undoubtedly a declining sport in Britain, on account of the increasing diminution in numbers of the quarry.

ELEPHANTS (PROBOSCIDEA).—Wild Elephants, whether African or Indian, naturally take high rank among "big game", chiefly because their enormous strength, and great ferocity when thoroughly aroused (especially if they are "rogues"), are liable to make them exceedingly dangerous antagonists. But the great perfection to which firearms have now attained render even these great beasts no match for the most destructive member of the Mammalia—Man.

HOOFED MAMMALS (UNGULATA). — Rhinoceroses, of course, reckon as "big game", and, as a rule, seem to be inoffensive enough, though sufficiently dangerous when wounded. Under such circumstances the two-horned White and Black Rhinoceroses of Africa (*Rhinoceros simus* and *Atelodus bicornis*) bring the long front horn into action, while the one-horned Indian species (*R. Indicus*) can bite with terrible effect.

The Hippopotamus (*Hippopotamus amphibius*) is sufficiently formidable when attacked from boats to give it a place among sporting mammals. But to kill it with a rifle from a place of security on the bank of its native river is simply a variety of target-shooting.

Among the many other Ungulates that are pursued for sport some are especially esteemed on account of their pluck and dangerous qualities, *e.g.* the African or Indian Buffaloes and the Wild Boar, while the great speed or agility in climbing of others furnish the requisite zest to the chase, as in the case of Deer, Antelopes, or Ibexes.

The joys and dangers of "pig-sticking", as pursued with reference to the Wild Boar (*Sus scrofa*) of Europe, his Indian cousin (*S. cristata*), and the African Wart-Hog (*Phacochærus*), have been fully described by many authors, and need no mention here. Regarding the Peccaries (*Dicotyles*) of America, something has already been said (see p. 334).

To give here even a brief account of the numerous swift runners or active climbers which belong to the Ungulata, and provide many varieties of sport, is both impossible and unnecessary. Among them the Red Deer (*Cervus elaphus*, fig. 1265) may perhaps

be given first place, at least from the English stand-point, and though the glories of stag-hunting have faded so far as Britain is concerned, innumerable trophies still attest the important place it once held in our national life. Deer-stalking in the "deer forests" of Scotland is excellent sport, but not comparable to hunting the wild animal in the old-time fashion, which, in this country, is now only possible on Exmoor. Regarding a third variety of the sport once popular in Britain Lord Granville Gordon makes the following very apposite remarks (in *Sport in Europe*):—"True we can still pursue him in what might be described as a pickled state, with horns shorn off, around the purlieus of Windsor, or in one or two other places, but, pleasant though the run may actually be, the 'sport' cannot stand close investigation, for sport consists in the strategy and skill of man in pursuing and capturing a wild animal. It loses all its charm and all its poetry when the game is first, as it were, tethered". Wild Red Deer are fortunately more numerous in other parts of Europe, *e.g.* in Hungary, than in Britain, but stalking and driving are in most cases the chief methods employed. The following remarks by Paul Caillard (in *The Sports of the World*) are of interest as showing that stag-hunting is to this day practised in France on a considerable scale:—"If hunting generally is known as the 'sport of kings', then surely is stag-hunting particularly associated with the memories of mediæval courts, and, although some might not perhaps expect it, modern France preserves above all other lands the tradition and even the outward forms of the ancient *chasse*. . . . In many of our French forests it would be as great a heresy to kill a deer otherwise than before the hounds as ever it would on Exmoor, and many visitors to our meets have expressed their pleasure at the survival of such picturesque sport."

Fig. 1265.—Red-Deer Trophy

GNAWING MAMMALS (RODENTIA).—Coursing the Hare with greyhounds is a very ancient form of amusement, which appears to have been indulged in by the Assyrians (fig. 1266). We next hear of it in Greece, and many details are given by Arrian (born

A.D. 90) in his work on coursing. The ancient Gauls were experts in this form of sport, which was probably introduced into Britain from their country. With us, however, it is now almost entirely replaced by hare-hunting with harriers, which supplies much of the interest of fox-hunting at considerably less expense. We know from Xenophon (B.C. 400) that the ancient Greeks in his time pursued the hare with two kinds of dog, the nature of which is doubtful, though they were certainly not greyhounds. It is hardly necessary to add that the sporting value of the Hare is found in its great speed, coupled with considerable ingenuity in "doubling", calculated to baffle even the swift greyhound.

The passion for sport, which is so thoroughly British, is

Fig. 1266.—Hares coursed by Greyhounds, as depicted on the edge of an Assyrian bronze dish.

gratified and kept alive among those with slender means by the possibilities which the inexpensive Rabbit (*Lepus cuniculus*) offers. The use of the Ferret has already been indicated (see p. 369). Nor even here do we reach the lowest plane, for the Brown Rat (*Mus decumanus*) undoubtedly seems to minister in no small degree to the sporting instincts of a considerable fraction of the community, though it would not be admitted into an orthodox work on Sport.

BIRDS (AVES) HUNTED FOR SPORT

In the palmy days of falconry the Grey Heron (*Ardea cinerea*) was, of course, the chief bird pursued for sport, but hawking (for Rooks, Larks, &c.) is now practised by the few (see p. 369), having fallen from its once high estate owing to the introduction of and constant improvement in firearms. Among the numerous species which now fall victims to the art of the gunner the GAME-BIRDS (GALLINÆ) take first place, and of these, in this country, three are pre-eminent, *i.e.* Pheasant (*Phasianus Colchicus*), Red

Grouse (*Lagopus Scoticus*), and Partridge (*Perdix cinerea*). Other well-known members of the group are: Capercailzie (*Tetrao urogallus*), Black Grouse (*Lyrurus tetrix*), Ptarmigan (*Lagopus mutus*), and Quail (*Coturnix communis*).

In many kinds of shooting one is rather inclined to think that things are made too easy for the gunners, not all of whom can be called good shots, and the size of the "bag" too often appears to be the object of overmuch attention. It is clear that both these tendencies greatly diminish the true "sporting" element. The following quotations show that some sportsmen are inclined to compare our own methods unfavourably with those of "the good old days". Nicholas Everitt (in *The Sports of the World*) thus speaks on the point:—"In England, in the old days, our forbears were wont to sally forth in the early morning, before the autumnal dews had left the grass and undergrowth, accompanied by their favourite pointers, setters, or spaniels, to double the hedgerows and to hunt the commons and likely places for pheasants, when, if they obtained as many single birds as some of the modern school of sportsmen now require hundreds, they would return home contented with their bag and lot". The Marquess of Granby (in *English Sport*) speaks still more strongly:—"But, nevertheless, it is open to question whether there is as much real keenness about working for their sport amongst the younger generation of gunners as there used to be twenty or thirty years ago, let alone a century. A wild, rough day's shooting does not nowadays apparently appeal to many. The large majority of gunners would not say 'thank you' for the offer of such a day's sport. It would look as if the deliberately competitive system of shooting, which now so largely prevails—by which I mean that very often the owner of one shooting-place seems to vie with the next-door one as to the amount of game he can kill off his property, and appears seriously annoyed if he hears that anyone round about him has had an exceptionally heavy day's sport, or one better, as regards numbers, than any he can produce—has to a great extent unfamiliarized the rising and just risen race of sportsmen with those days when hard walking, and consequently good condition, coupled with some knowledge of wood and field craft, were necessary if any satisfactory results were to be obtained."

The Red Grouse (*Lagopus Scoticus*) is a game-bird of par-

RED GROUSE (*Lagopus Scoticus*) GLIDING UP TO THE GUNS

The Red Grouse or Muirfowl is here selected for illustration not only on account of its importance as a game-bird, but also because it is the only member of its class peculiar to our islands. In Great Britain it ranges from the Orkneys to Shropshire and Glamorgan, and is also found in Ireland, though less abundantly. The Red Grouse is closely related to the Willow Grouse (*Lagopus albus*), which ranges right round the colder parts of the Northern Hemisphere, but it does not, like this species and the Ptarmigan (*L. mutus*), turn white in winter, though there are seasonal changes in the plumage. It is popularly supposed that the date at which grouse-shooting begins determines the rising of Parliament, and although the notion is erroneous its origin is not far to seek.

RED GROUSE (LAGOPUS SCOTICUS) GLIDING UP TO THE GUNS

ticular interest, as it happens to be peculiar to Britain. The old method of "walking" has now mostly given place in this country to "driving". The latter practice, curiously enough, is more favourable to the maintenance of sufficient numbers on a grouse-moor than the former. It is suggested that when the birds are driven the old ones are the first to glide up to the guns, so that the undue destruction of immature individuals is obviated. Besides which the old birds are said to be so quarrelsome as seriously to interfere with the domestic plans of their juniors.

Fig. 1267.—Flamingoes (*Phœnicopterus roseus*)

PERCHING BIRDS (PASSERES).—Hawking for Rooks (*Corvus frugilegus*) and Sky-Larks (*Alauda arvensis*) has already been mentioned (see p. 369).

PLOVERS (LIMICOLÆ). — Woodcock (*Scolopax rusticola*) and Snipe (*Gallinago cœlestis*) are familiar sporting birds.

BUSTARDS (ALECTORIDES).—The Great Bustard (*Otis tarda*), once a native of Britain, affords good sport in several European countries, including Hungary, Russia, Roumania, Spain, and Portugal. The Little Bustard (*O. tetrax*) is also the object of sporting attentions.

DUCKS, GEESE, SWANS, AND FLAMINGOES (ANSERES).—The art of wild-fowling is largely applied to the members of this group (also to Woodcock and Snipe) on inland waters, in swampy districts, and along low shores. Our own Norfolk Broads furnish an example. In sport of the kind punting plays a large part.

The Flamingo (*Phœnicopterus roseus*, fig. 1267) is one of the most interesting birds that falls to the gun of the fowler in the Peninsula. Chapman & Buck (in *Wild Spain*) thus describe the method pursued: — " Flamingoes are always shy and watchful birds, and their great height gives them a commanding view of threatening dangers; but there are degrees in intensity of wildness, and despite the unquestionable difficulty of flamingo-shooting, we would certainly not place these long-necked birds in the first rank among impracticable wild-fowl. Wild geese, for example, many of the duck-tribe, and nearly all the larger raptores far exceed them in incessant vigilance and downright astuteness. Flamingoes, however, will not, as a rule, permit of approach by the ordinary Spanish method of the stalking-horse, or *cabresto*: while the treacherous pony is still two gunshots away, the warning croak of the sentries is given, and at once the whole herd start to walk away, opening out their ranks as they move off. The method we found most effective to secure them was by partially surrounding a herd with a line of mounted men, who rode far out beyond them and then drove them over our two guns, each concealed behind his horse and crouching knee-deep in water. Of all the dirty work that wild-fowling in its many forms necessitates, this flamingo-driving takes the palm. It is mud-larking pure and simple, man, horse, and gun alike encased in a clinging argillaceous covering like the street-Arab amphibians below London Bridge. It is a fine sight to see a big flight of flamingoes, say five hundred, coming well in to the gun—*entrando bien á la escopeta*! The whole sky is streaked with columns of strange forms, and the still air resounds with the babel of discordant croaks and cries. How wondrously they marshal those long uniform files, bird behind bird, without break or confusion, and how precisely do those thousand black wing-points beat in rapid regular unison! Flamingoes are not 'hard' birds: their feathers being loose and open, and the extremely long neck a specially vulnerable part, they may be brought down from a considerable height even with small shot."

REPTILES (REPTILIA) HUNTED IN SPORT

About the only Reptile that can be considered as furnishing anything in the nature of sport is the American Alligator

(*Alligator Mississippiensis*), native to the south-eastern part of the United States. The "'Gator" is shot from the bank or from a boat, and is sometimes attracted by tying up a dog as a bait.

FISHES (Pisces) HUNTED IN SPORT

The "gentle craft" has always had, and always will have, a large number of supporters. It of course finds its highest expression in fly-fishing, as applied to species the capture of which

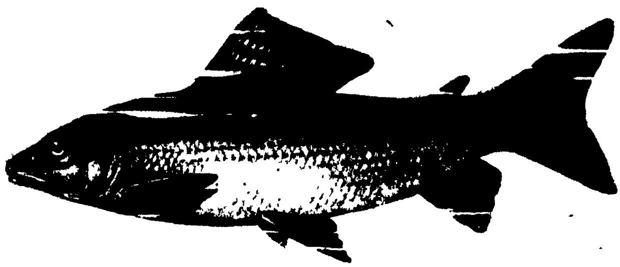

Fig. 1268.—Grayling (*Thymallus vulgaris*)

calls for the exercise of patience, skill, and other sportsmanlike qualities.

Salmon (*Salmo salar*) and Trout (*S. fario*, &c.) are generally regarded as taking first rank among game-fishes, and the Grayling (*Thymallus vulgaris*, fig. 1268) may also be given an honourable place. H. A. Rolt's appreciation of the last-named fish (in *The Sports of the World*) is well worth quoting, especially as the pleasures of angling for Grayling are much less familiar than the joys of the fisher for salmon or trout:—"It is remarkable what a peculiar fascination there is in connection with the capture of the grayling with the artificial fly. Some men who have killed hundreds of trout fall hopelessly in love with the sport the 'gray lady of the stream' affords from the very first moment they enter the lists against it, and infinitely prefer the autumn and winter pastime it provides to any other branch of angling.

The enthusiasm and all-absorbing interest it evokes in the angler are incomprehensible even to many disciples of the good and observant Walton himself, for to sally forth, fly-rod in hand, when the ground is hard with frost or the fields are white with snow, seems to them to savour somewhat of folly and madness. In the soft, bright spring-time it is delightful to wander by the rippling stream and stalk the spotted trout, to the accompaniment of the glorious melody of birds—to watch the budding foliage bursting into new life, and gaze upon the river shining like gold

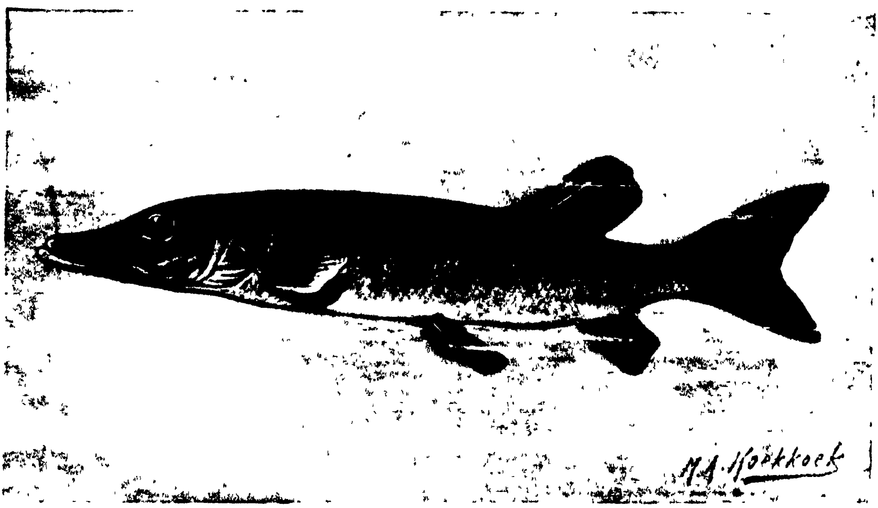

Fig. 1269.—Pike (*Esox lucius*)

in the dancing sunlight. On quiet, restful summer evenings, too, the splash of the fish as they enjoy an abundant feast of Duns is the sweetest of music to the angler's ear, and he may perchance induce his quarry to look with favour upon the artifically-dressed copy of the fly he offers them, and grass a brace or two of lovely specimens ere darkness compels him, as a thorough sportsman, to leave the stream. But it is amid different and far less exhilarating surroundings that the grayling fisher's labours begin and are continued to the end. As autumn approaches, the rise of fly becomes sparse and erratic, and when September's days are out, the trout fisher finds his occupation gone. Thymallus steps in to fill what would otherwise be a great gap in his piscatorial life. But for the grayling, his rods would hang upon the wall during the long winter months,

'a mournful, half-accusing row', unused, and perhaps uncared for."

Some of the "coarse fish" also provide good sport, particularly the Pike (*Esox lucius*, fig. 1269), the Barbel (*Barbus vulgaris*), and the Perch (*Perca fluviatilis*).

Sea-fishing in many forms also has innumerable votaries. If size, strength, and game qualities are taken as the criteria, the great Tarpon (*Megalops thrissoides*), common off the coast of Florida, must be given a prominent position. It is to all intents and purposes a gigantic herring, which may be as much as five feet in length; and W. H. Grenfell says of it (in *The Sports of the World*) that ". . . until a new sporting fish is found I think the tarpon in the sea, as the salmon in fresh water, can still claim to be the most exciting quarry of the angler with the rod and line". Fishing for the Tunny (*Orcynus thynnus*) off the south coast of Spain would also seem to be a worthy occupation for the brethren of the rod, and specimens captured in this way have scaled as much as 50 pounds.

Among native marine fishes, the Grey Mullet (*Mugil capito*) and Bass (*Labrax lupus*) are perhaps the most esteemed, on account of their sporting qualities and the difficulties attending their capture. Both frequent estuaries, and the Bass is a near relative of the Perch.

CHAPTER LXXIII

UTILITARIAN ZOOLOGY—ANIMAL PETS

It is the merest commonplace to say that a considerable number of animals are either domesticated or kept in captivity as pets, and those which have perhaps the best right to the name simply afford gratification to human tastes, or, it may be, serve as objects of affection. In the latter case the pet-keepers may either have a genuine liking for animals, or else the over-fed lap-dog, the spoilt feline, or the loquacious parrot may be the recipient of caresses that under different circumstances might have been bestowed upon some specimen or other of that alleged highest Mammal—*Homo sapiens.*

MAMMALS (MAMMALIA) AS PETS

MONKEYS (PRIMATES).—On account of their intelligence many species of Monkey find favour as pets among both civilized and uncivilized races. But most of them are so terribly mischievous that only a sailor or the late Frank Buckland could put up with their pranks for any lengthened period. It is said that even Buckland found his two favourites, "Tiny" and "The Hag", trying at times, and a friend recommended him to build a cage for himself in the middle of his study. It is interesting to note that the keepers in Zoological Gardens often make great pets of their charges, especially when these happen to be intelligent apes, as, *e.g.*, Chimpanzees (fig 1270).

The Marmosets are attractive little creatures, so far as appearance goes, and are not infrequently kept as pets; but they are rather lacking in intelligence, and apt to impose a tax on the olfactory organs.

FLESH-EATING MAMMALS (CARNIVORA).—The fact that this order includes both Dog and Cat makes it of primary importance from the present stand-point.

The Dog (*Canis familiaris*), man's earliest friend among the animals, is undoubtedly the "king of pets", for even the commonest mongrel is full of intelligence, and overflows with affection for his owner, even when subjected to much ill treatment, as is but too often the case. Among the breeds which have been brought into existence simply to be petted may be mentioned—the Italian Greyhound, the Pug (a diminutive and

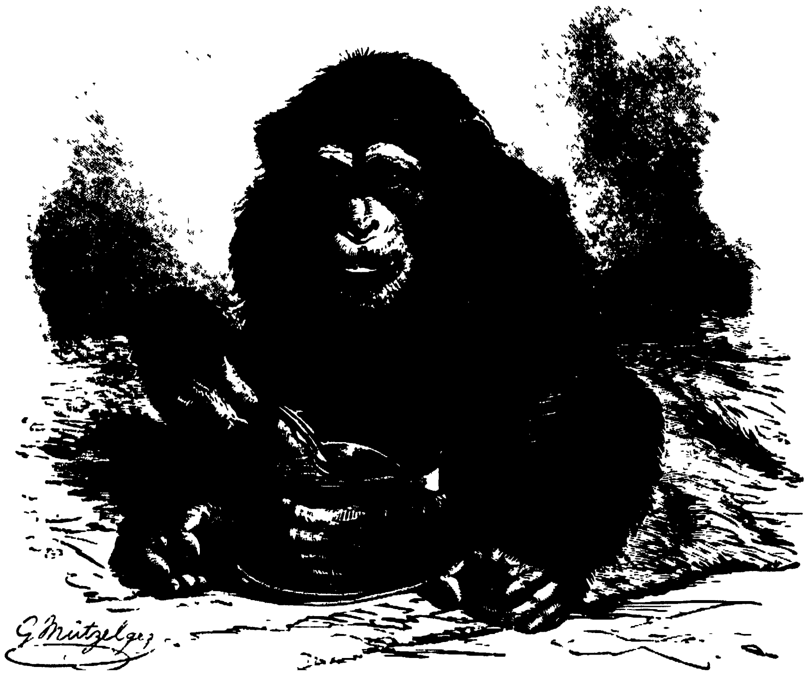

Fig. 1270.—Young Chimpanzee (*Anthropopithecus niger*)

particularly ugly relative of the mastiff, fig. 1271), the King Charles Spaniel, the Skye Terrier, the "Toy" Terrier, and the Poodle. The last is particularly clever in learning tricks, as may often be noted in exhibitions of performing dogs. The Dalmatian and the Hairless Dog of Japan are both curiosities in their way. No better example than these and other breeds of Dog could be given to show the effect of human interference upon the normal course of evolution. Modifications in shape, size, proportions, colour, hair, and even temperament have been brought about within a comparatively short space of time, in a

way that suggests nothing so much as "clay in the hands of the potter". By taking advantage of variations that occur naturally it is possible to "make to order" almost any desired pattern of the canine race.

The Cat (*Felis domesticus*).—The differences between the various breeds of this animal are by no means so striking as those existing between the different sorts of dog, and chiefly relate to colour, character of the fur, and relative length of the tail. It has been suggested that the stripes of the "tabby" indicate a strain derived from the ordinary Wild Cat (*Felis catus*) of Europe. Among both wild and tame animals it is not uncommon to find individuals in which pigment is either present in excess, or else largely deficient. Illustrations of this are afforded by "nigger" rabbits and white blackbirds. Such "sports" are respectively described in technical language as examples of "melanism" and "albinism". The jet black cat once associated with magical practices, and the pure white pussy with blue eyes are thus classed. Why albino cats should be usually deaf, as appears to be the case, is as yet unexplained. The long and handsome coats of the Persian or Angora Cats (fig. 1272) renders them great favourites among those who admire felines, though they seem rather apt to be short-tempered, if one may be permitted to say so.

Fig 1271.—Pug Dog

That the indigenous cats of the Isle of Man are devoid of tails is known to all; some of the Crimean cats are said to be similarly deficient, and the same peculiarity has been noticed in some Japanese individuals. Lydekker (in *The Royal Natural History*) thus speaks of some other peculiar varieties:—"In Siam there is a breed of cats reserved for royalty, characterized by

their uniform, and often dark, fawn colour, their blue eyes, and the presence of two or more perfectly bald spots on the forehead. Siam, together with Burma, also possesses a breed known as the Malay cat, in which the tail is but of half the usual length, and is often, through deformity in its bones, tightly curled up into a knot."

The present writer is not a great lover of cats, but, desiring to be just, adds the following appreciation by Romanes (in *Animal Intelligence*) of this domestic carnivore:—"The cat is unquestionably a highly intelligent animal, though, when contrasted

Fig. 1272.—Persian Cat

with its great domestic rival the dog, its intelligence, from being cast in quite a different mould, is very frequently underrated. Comparatively unsocial in temperament, wanderingly predaceous in habits, and lacking in the affectionate docility of the canine nature, this animal has never in any considerable degree been subject to the psychological transforming influences whereby a prolonged and intimate association with man has so profoundly modified the psychology of the dog. Nevertheless, the cat is not only by nature an animal remarkable for intelligence, but, in spite of its naturally imposed disadvantage of temperament, has not altogether escaped those privileges of nurture which unnumbered centuries of domestication could scarcely fail to supply. Thus, as contrasted with most of the wild species of the genus when tamed from their youngest days, the domestic cat is conspicuously of less uncertain temper towards its masters

—the uncertainty of temper displayed by nearly all the wild members of the feline tribe when tamed being, of course, an expression of the interference of individual with hereditary experience. And, as contrasted with all the wild species of the genus when tamed, the domestic cat is conspicuous in alone manifesting any exalted development of affection towards the human kind; for in many individual cases such affection, under favouring circumstances, reaches a level fully comparable to that which it attains in the dog."

Passing notice may be given to the Mangoustis or Mungooses, also known as Ichneumons, of which one, the Egyptian Mungoose

Fig. 1273 —Indian Mungoose (*Herpestes griseus*)

(*Herpestes ichneumon*), has been domesticated in Egypt from time immemorial, while the common Indian Mungoose (*H. griseus*, fig. 1273) is commonly kept as a pet in its native country, and appears to be both intelligent and affectionate. The latter species is known to the readers of Kipling as "Rikki-tikki".

Gnawing Mammals (Rodentia).—Human influence has resulted in the production of a large number of varieties of Rabbits, Rats, and Mice, some of which have been alternately tended and neglected by almost every boy. Upon the Rabbit (*Lepus cuniculus*) one of the most remarkable results of domestication has been, in certain breeds, the great elongation of the ears, and the drooping position they have assumed. There has also been a large amount of variation in the colour and character of the fur.

The various domesticated breeds of Rat (*Mus rattus*) and

Mouse (*M. musculus*) differ chiefly from one another in colour. The curious evolutions of "waltzing mice" appear to be due to defects in the structure of the internal ear.

Among other rodents serving as pets may be mentioned—the Alpine Marmot (*Arctomys marmotta*), the Dormouse (*Muscardinus avellanarius*), the Squirrel (*Sciurus vulgaris*), and the Guinea-Pig.

BIRDS (Aves) AS PETS

The number of species represented among pet-birds, including those which are better described as "captives", is very large indeed, and it will be unnecessary to mention more than a few of them.

Perching Birds (Passeres).—Many of these are domesticated on account of their beauty or vocal powers, or both, and not a few of these have exchanged the sweets of liberty for a small and uncomfortable cage. To treat small birds in this fashion is scarcely less than criminal. Large aviaries, of course, are on a somewhat different footing. Fortunately the objection does not apply to the most popular of all pet birds, the Canary (*Serinus canarius*, fig. 1274), of which countless generations have been brought up in captivity, and of which the numerous strikingly different breeds may almost be regarded as artificial products. Newton makes the following remarks about this bird (in *A Dictionary of Birds*):—"It abounds not only in the islands whence it has its name, but in the neighbouring groups of the Madeiras and Azores. It seems to have been imported into Europe very early in the sixteenth century. Turner in 1544 speaks of the birds '*quas Anglia aues canarias uocat*', a statement confirmed by the poet Gascoigne, who died in 1577, and speaks . . . of 'Canara byrds'. Gesner had not seen one in 1555, but he gave an account of it . . . , communicated to him by Raphael Seiler of Augsburg under the name of *Suckeruögele*. The wild stock is of an olive-green, mottled with dark-brown above and greenish-yellow beneath. All the bright-hued examples we now see in captivity have been induced by carefully breeding from any chance varieties that have shown themselves; and not only the colour but the build and stature of the bird have in this manner been greatly modified. The change must have begun early, for Hernandez, who died in 1587, described the bird . . . as being

wholly yellow (*tota lutea*), except the end of its wings. Of late the ingenuity of 'the fancy', which might seem to have exhausted itself in the production of top-knots, feathered feet, and so forth, has brought about a still further change from the original type. It has been found by a particular treatment, in which the mixing

Fig. 1274.—Canaries (*Serinus canarius*). 1, Wild form; 2, common yellow; 3, crested variety; 4, Scotch fancy.

of large quantities of cayenne-pepper with the food plays an important part, the ordinary 'canary yellow' may be intensified so as to verge upon a more or less brilliant flame colour. Birds which have successfully undergone this forcing process, and are hence called 'hot canaries', command a very high price, for a large proportion die under the discipline, though it is said that

they soon become exceedingly fond of the exciting condiment." Space forbids any attempt to describe the methods by which the German fanciers of the Harz valleys teach canaries the notes of other birds, or even various tunes.

Another well-known and extremely pretty cage-bird is the Java Sparrow (*Munia oryzivora*), which has long been an object of domestication, and is distinguished by its extreme tameness.

On account of their intelligence, sprightliness, and imitative powers, the Raven, Jackdaw, Magpie, and Starling appeal to many persons more than Canaries and other small singing-birds. They are not, however, so frequently seen in captivity, partly on account of the thievish propensities of all but the last.

PARROTS (PSITTACI).—Among the many species of this group which are kept in captivity, the common Grey Parrot (*Psittacus erithacus*), native to tropical Africa, probably stands highest in public estimation. This is partly due to its extreme liveliness, but chiefly on account of the clever way in which it learns fragments of human speech, and imitates familiar sounds, such as the drawing of corks and the like. The often singularly malapropos nature of the remarks and sounds greatly increase their charm.

Parrots have been known and appreciated for more than two thousand years as clever imitative birds, often with brilliant plumage. Some of the Indian species appear to have been those first known to Europeans, while the resources of Africa were exploited later on. Regarding this, Newton (in *A Dictionary of Birds*) speaks as follows:—"That Africa had parrots does not seem to have been discovered by the ancients till long after, as Pliny tells us (vi, 29) that they were first met with by explorers employed by Nero beyond the limits of Upper Egypt. These birds, highly prized from the first, reprobated by the moralist, and celebrated by more than one classical poet, as time went on were brought in great numbers to Rome, and ministered in various ways to the luxury of the age. Not only were they lodged in cages of tortoise-shell and ivory, with silver wires, but they were professedly esteemed as delicacies for the table, and one emperor is said to have fed his lions upon them. . . . With the decline of the Roman Empire the demand for parrots in Europe lessened, and so the supply dwindled, yet all knowledge of them was not wholly lost, and they are occasionally mentioned by one writer or another until in the fifteenth century began that

career of geographical discovery which has since proceeded uninterruptedly. This immediately brought with it the knowledge of many more forms of these birds than had ever before been seen, for whatever races of men were visited by European navigators—whether in the East Indies or the West, whether in Africa or the islands of the Pacific—it was almost invariably found that even the most savage tribes had tamed some kind

Fig. 1275.—Macaw (*Ara*)

of parrot; and, moreover, experience soon showed that no bird was more easily kept alive on board ship and brought home, while, if it had not the merit of 'speech', it was almost certain to be of beautiful plumage."

One of the prettiest pets among these birds is the Grass-Parakeet or Budgerigar (*Melopsittacus undulatus*) of Australia. Yellow, green, and black are the chief components of the colour scheme, but the two central tail-quills are blue, and there is a patch of the same hue on either side of the face.

The affectionate little Love-Birds are deservedly popular.

The name is properly applied to certain African species (of *Agapornis*), but it may also be taken to include the Parrotlets (*Psittacula*) of South America.

The sprightly crested Cockatoos (*Cacatuidæ*) of the Australian region do not lack their admirers, while for gaudy coloration few birds surpass the long-tailed Macaws (species of *Ara*, fig. 1275), which range from Mexico into South America.

REPTILES (REPTILIA) AS PETS

Reptiles make no appeal to the affections or fancies of most persons, though various species prove attractive to some. The ancient Egyptians, as everyone knows, regarded the Nile Crocodile (*Crocodilus Niloticus*) as sacred, and made a sort of pet divinity of the creature, but this hardly comes within the scope of the present section. Some persons have a fancy for certain Snakes, such as our common and innocuous Grass-Snake (*Tropidonotus natrix*), and the Indian snake-charmers tame the Cobra (*Naia tripudians*), actuated, however, by strictly business motives. Regarding the latter, Gadow (in *The Cambridge Natural History*) speaks as follows:—"This cobra is used by Indian conjurers. The 'dance' is the habit of these snakes of erecting themselves, when agitated, upon the hinder third or quarter of their length, whilst they spread out the hood and sway the head and neck to the right and left, always in an attitude ready for striking. They are docile, and by nature not vicious. Most of the performing cobras have their teeth drawn, and they then know well that they cannot bite. They only strike at the hand, just as uninjured specimens soon avoid biting into the iron rod with which they are lifted up in menageries. The drawing of the teeth is an operation which has to be repeated, since reserve-teeth soon take the place of the lost pair."

Various Lizards are or have been tamed, and some of them are very attractive, *e.g.* the beautiful Green Lizard (*Lacerta viridis*). The Common Gecko (*Tarentola Mauritanica*) of North Africa and South Spain and Portugal often lives in houses in a half-domesticated condition, running over the walls and ceilings in pursuit of flies. And such lizards are sometimes actually tamed.

The most familiar domesticated reptile in this country is the Grecian Tortoise (*Testudo Græca*), though it can scarcely be

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The most familiar domesticated reptile in this country is the Grecian Tortoise (*Testudo Græca*), though it can scarcely be

called an interesting pet. Gilbert White has immortalized one specimen, which was over forty years old when it came into his possession in 1780, and died fourteen years later. But, for longevity, it would be hard to beat some of the huge land-tortoises which were at one time common in the islands of the Indian Ocean. Regarding one species (*Testudo Sumeirei*) Gadow makes the following interesting remarks (in *The Cambridge Natural History*):—"This kind is supposed to have been the species peculiar to the Seychelles. In 1766 five large tortoises were brought from the Seychelles to Mauritius by Chevalier Marion de Tresne. Of these only three were alive in 1898, two in Mauritius and one in London; the latter specimen soon died in the Zoological Gardens. One of the two survivors, the last of their race, is famous. It was kept at Port Louis, and when Mauritius became a British possession in 1810 the tortoise was especially mentioned and taken over. It still [1900] lives there in the grounds of the barracks of the garrison. According to the proverbial oldest inhabitants, it had in 1810 already reached its present size, namely, a shell-length of about 40 inches, with a greatest circumference of . . . 8 feet 6 inches. When walking it stands about . . . 25.4 inches high, . . . and it can then carry with ease two full-grown men on its back. This old male is now nearly blind, but is otherwise of regular habits and in good health. Although it has been known for nearly 150 years, it had to wait for its scientific name until the year 1892."

AMPHIBIANS (AMPHIBIA) AS PETS

Ordinary Toads and Frogs have at times been subjected to domestication, and are by no means wanting in interest and intelligence. The pretty little Green Tree-Frogs of Europe (*Hyla arborea*) are less known as pets than they deserve to be. In North and Central America the Horned Toad (*Phrynosoma*) is subjected to a certain amount of domestication.

FISHES (PISCES) AS PETS

The greatest favourite in the aquarium is probably the Gold-Fish (*Carassius auratus*, fig. 1276), a kind of carp native to China and Japan. Domestication has eliminated dark pigment from its

skin, leaving only the golden-yellow hue from which its name is derived. Various monstrosities have also been produced, especially the "Telescope Fish", with eyes on short projections, and a large abnormal tail-fin. It is stated that the Gold-Fish was originally introduced into this country in 1691.

Another aquarium favourite is the Paradise-Fish (*Polyacanthus viridi-auratus*, fig. 1276), domesticated in China from very remote

Fig. 1276.—Pet Fishes. 1, Gold Fish (*Carassius auratus*; 2, "Telescope" variety of same. 3, Paradise Fish (*Polyacanthus viridi-auratus*).

times, and only known in captivity. Its golden sides are cross-barred with red, and some of its fins are abnormally developed (see also vol. iii, p. 427).

The Siamese keep certain pugnacious fishes in captivity in order to enjoy the sight of their combats.

INSECTS (INSECTA) AS PETS

Some Insects are excitable, and can easily be induced to fight together. The ingenious Chinese keep various species in captivity in order to enjoy these mimic combats. Their list includes Mantids, Beetles, Grasshoppers, and Crickets. The same curious kind of amusement is practised to some extent in Italy. Nor must the evolutions of performing Fleas be forgotten.

CHAPTER LXXIV

UTILITARIAN ZOOLOGY—ANIMAL PRODUCTS USED FOR DECORATIVE PURPOSES—ANIMAL ÆSTHETICS

We have here first to consider the chief animal products employed for decorative purposes, and afterwards briefly to review the principles of Animal Æsthetics.

ANIMAL PRODUCTS USED FOR DECORATIVE PURPOSES

A number of animal products which were originally valued by mankind chiefly as ministering to the primary necessities of life, now derive their main worth from the ornamental or decorative possibilities they present, or they are, at any rate, in increased demand on that account. Furs, horns, silk, and the skins of some birds belong to this category (see pp. 303, 310, 259, and 308).

We are especially concerned in this chapter with products which from the first have been employed by way of ornament or decoration, sometimes also as a means of heightening the attractions of materials of other kind.

Decorative Products of Mammals (Mammalia).—Some Mammals have been ruthlessly hunted down by man for the sake of the ivory furnished by their teeth. Prominent among these are the Elephants (*Elephas*), and, as will be gathered from fig. 1277, the tusks of the African species may attain very large dimensions. The extinct Mammoth (*E. primigenius*) has also long been known as a source of "fossil ivory". The tusks of Walrus (*Trichechus rosmarus*) furnish a further supply, as does the long spirally-grooved "horn" of the male Narwhal (*Monodon monoceros*), of which two are occasionally present in the same animal. While the tusks of the Walrus are canine teeth, those of the other animals mentioned are incisors.

Many of the trophies of sport are decidedly ornamental, such as the skins of beasts of prey, the antlers of deer, the heads of fox or wolf, the prepared feet of the elephant, &c. &c. Among primitive races such things as necklaces of tigers' or lions' claws are greatly esteemed.

DECORATIVE PRODUCTS OF BIRDS (AVES).—The beautiful plumage of many birds seems always to have appealed to the human colour-sense or appreciation of form, and much slaughter of certain members of the feathered race has resulted on the part of savage races, often to minister to the vanity of other races sometimes supposed to be fully civilized. The trade in ostrich-feathers (see p. 251) is a legitimate branch of the plume-industry, and nothing can be said against the use of the cast feathers of beautiful forms like the different species of Peacock. But, on the other hand, the wholesale massacre that takes place every year of many exquisitely lovely species, purely to satisfy the love of finery which has been inherited by civilized nations from barbarian ancestors, deserves the most unsparing censure. Birds of Paradise, Sun-Birds, Humming-Birds, and Egrets are prominent in the long list of victims.

Fig. 1277.—Tusks of African Elephant

DECORATIVE PRODUCTS OF REPTILES (REPTILIA).—The skins of Crocodiles and various lizards are used for ornamental purposes, but the most important reptilian product is tortoise-shell, which consists of the horny epidermic shields of the widely-distributed Hawksbill Turtle (*Chelone imbricata*, fig. 1278). When softened

by heat these can be worked up into all sorts of artistic objects. Very undesirable practices are often resorted to in procuring the raw material, as will be seen from the following quotation from Tennent (in *The Natural History of Ceylon*).—"If taken from the animal after death and decomposition, the colour of the shell becomes clouded and milky, and hence the cruel expedient is resorted to of seizing the turtles as they repair to the shore to deposit their eggs, and suspending them over fires till heat

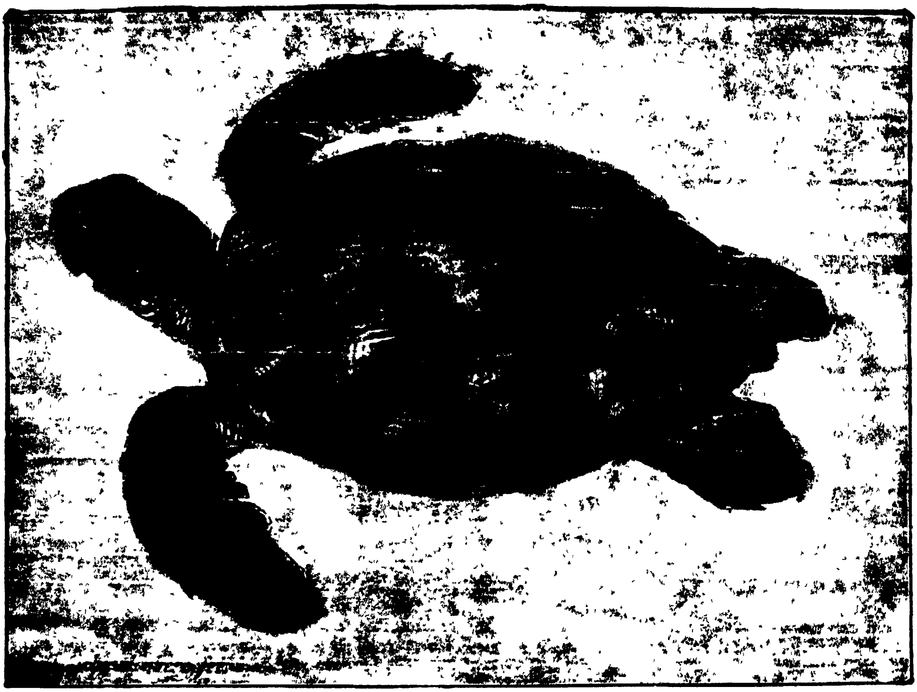


Fig. 1278.—Hawksbill Turtle (*Chelone imbricata*)

makes the plates on the dorsal shields start from the bone of the carapace, after which the creature is permitted to escape to the water. At Celebes, where the finest tortoise-shell is exported to China, the natives kill the turtles by blows on the head, and immerse the shell in boiling water to detach the shields. Dry heat is only resorted to by the unskilful, who frequently destroy the tortoise-shell in the operation."

Decorative Products of Fishes (Pisces).—Ornamental leather is made from the skins of Dog-Fishes and Sharks (shagreen), while the scales of Dace (*Leuciscus vulgaris*) and

Bleak (*L. alburnus*) are employed in the manufacture of artificial pearls.

Decorative Products of Molluscs (Mollusca). — The shells of the Pearly Nautilus, of many univalves, and numerous bivalves, are largely used for purposes of personal decoration by savage races, and to some extent by civilized ones. Some of them are worked up into ornamental knick-knacks even in British watering - places, while the Chinese are singularly skilful in the construction of the images of gods, human beings, animals, and plants, from a variety of small shells (fig. 1279).

Fig. 1279.—Chinese Shell-ornament

Sea-Snails (*Gastropoda*).—The thick shells of some Sea-Snails (species of *Cassis*, &c.) are made up of layers of different tints, which has rendered them a favourite material upon which to carve cameos (fig. 1280). Pink pearls are the pathological products of certain species, especially the large Conch - Shell (*Strombus gigas*) of the West Indies.

The most famous product of Sea-Snails was, however, the royal dye

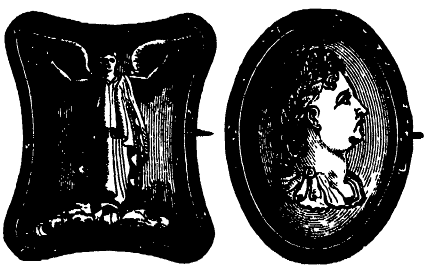


Fig. 1280.—Shell-Cameos

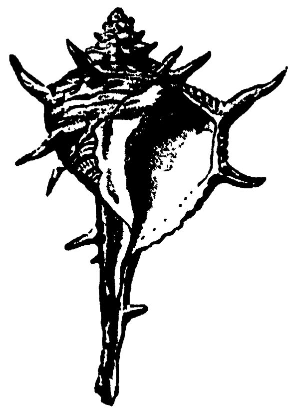


Fig. 1281.—Murex Bronderi

known as Tyrian Purple, prepared by the ancient Phœnicians from species of Purpura and Murex (fig. 1281). It is secreted by a gland in the gill-cavity, closely connected with the intestine.

The explorations of the Phœnicians westward, which had no small influence upon the course of history, were partly conducted with the object of securing larger supplies of these molluscs.

Some of the travellers of the seventeenth and eighteenth centuries state that the natives of Ecuador and Costa Rica obtained a purple fluid from a species of Purpura, and used it to dye cotton. A kind of Sea-Slug (*Aplysia camelus*) is still used by the Portuguese for a similar purpose.

Bivalve Mollusca (*Lamellibranchia*).—Pearls and mother-of-pearl are chiefly derived from members of this group. Mother-of-pearl or nacre is the iridescent internal layer of the shell,

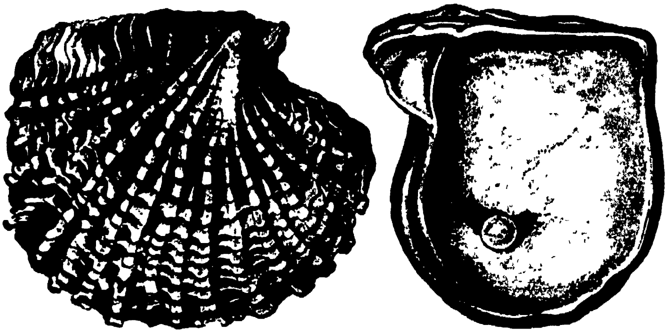


Fig. 1282.—Shells of Pearl-Oyster (*Margaritifera vulgaris*), and pearl of same.

while pearls consist of layers of similar material deposited round various foreign bodies which, in the most valuable kinds, are stages in the development of parasitic forms (see p. 204). The most important pearl-fisheries are those of the Red Sea, India, Ceylon, Queensland, some of the South Pacific archipelagoes, lower California, and the Pacific coast of Central America. The bivalve of greatest economic value in this connection is the Pearl-Oyster (*Margaritifera vulgaris*), which in reality is more of a mussel than an oyster, but belongs to a different family from either (*Aviculidæ*). The once important pearl-fisheries of Ceylon, after a record yield in 1891, benefiting the revenue of the island to the extent of hard on a million rupees, completely failed for an entire decade. As the outcome of this the pearl-oyster question has recently been investigated by Professor Herdman, assisted by Mr. James Hornell. These two experts have fully worked out the life-history of the tape-worm which leads to the formation of "orient pearls", and it is hoped that

the knowledge acquired will form the basis of measures by which the industry may be resuscitated. The first part of Herdman's *Report on the Pearl-Oyster Fisheries of the Gulf of Manaar* includes a very interesting historical sketch from which the following extract is taken;—"The pearl-fisheries of Ceylon, India, and the Persian Gulf, yielding the highly prized 'Oriental' pearl, are of very great antiquity. They are probably the most ancient fisheries still in existence, and seem to be carried on at the present day under very much the same conditions as 2000 or perhaps even 3000 years ago. These fisheries are referred to by various classical writers, and Pliny, after saying how highly valued the pearls are at Rome, refers to Taprobane [Ceylon] as 'the most productive of pearls of all parts of the world'. . . . But the Singhalese records take us to still earlier times. According to the 'Mahawanso', pearls figure in the list of native products sent as a present from King Vijáya of Ceylon to his Indian father-in-law in about 540–550 B.C.; and again when, in B.C. 306, King Devanampiyatissa sent an embassy to India the presents are said to include eight kinds of Ceylon pearls. The King's Hall in the Brazen Palace at Anuradhapura (B.C. 161) is said to have been decorated with native pearls. The mortar in the ruins of Polonaruwa shows the remains of the pearl-oyster shells which were used in its manufacture—no doubt the refuse of an early fishery. Many other references could be given. In the eighth to eleventh centuries, trade in the East was in the hands of the Persians and Arabs, and we find Arab writers alluding to the pearls. We know also that they enriched the kings of Ceylon in the days of Marco Polo (1291). One record, given by Friar Jordanus, says that in 1330 about 8000 boats were engaged in the pearl-fisheries of the Gulf of Manaar."

From the remote times mentioned in the above extract down to the present day the pearl-oysters have been collected by native divers, but it is not improbable that dredging will ultimately be the chief method employed.

Pearls are formed within a number of bivalves besides the one mentioned, nor are all of these marine, for the once famous British pearls were obtained from Fresh water Mussels. Purple pearls are formed within some of the Ark-Shells (*Arca*).

Decorative Products of Insects (Insecta).—There is not much to mention with regard to this group of animals. The

hard metallic-looking wing-covers or elytra of certain Beetles serve for various decorative purposes, and some of the more beautiful Butterflies are sometimes placed in glass cases and used as ornaments. Some of the Scale-Insects (*Coccidæ*) are the source of economic products of some importance in the present connection, *e.g.* the Cochineal Insect (*Coccus cacti*) furnishes red pigment (see p. 260). Objects known as "ground pearls" are found in the earth in various parts of the world, *e.g.* in the island of St. Vincent (West Indies), where they are made into necklaces, &c. They are in reality the encysted pupæ of Scale-Insects, covered by a hard substance looking like pearl or glass. The West Indian ones mentioned above belong to a species of Margarodes.

ANIMAL ÆSTHETICS

The course of human evolution has necessarily involved a gradually improving adaptation to surroundings, of which the outcome is seen in all the intricate details of modern civilization. Imaginative literature and the various branches of art are among the most remarkable results of this evolution, and the full discussion of their nature and origin is the province of that branch of philosophy known as Æsthetic. But as, after all, man is an animal, who has always lived among other animals that have profoundly influenced the course of his mental development, it naturally follows that the study of Æsthetic, as indeed of all other departments of philosophy, must look for its foundations among the principles of biology. The interdependence of natural science and philosophy is well brought out in the following quotation from Karl Groos (in *The Play of Animals*):—"Man's animal nature reveals itself in instinctive acts, and the latest investigators tell us that man has at least as many instincts as the brutes have, though most of them have become unrecognizable through the influence of education and tradition. Therefore an accurate knowledge of the animal world, where pure instinct is displayed, is indispensable in weighing the importance of inherited impulses in men. . . . The animal psychologist must harbour in his breast not only two souls, but more; he must unite with a thorough training in physiology, psychology, and biology the experience of a traveller, the practical knowledge of

the director of a zoological garden, and the outdoor lore of a forester. And even then he could not round up his labours satisfactorily unless he were familiar with the trend of modern æsthetics." To briefly indicate some of the chief points of contact between Biology and Æsthetics is all that can be attempted here, and those who wish to pursue the subject fully are referred to the works of Herbert Spencer, Bain, Baldwin, Romanes, and Lloyd Morgan, as also to Grant Allen's *Physiological Æsthetics*, Knight's *Philosophy of the Beautiful*, Bosanquet's *History of Æsthetic*, and Groos's *Play of Animals*.

No human being or highly-organized animal would be able to live for any length of time, nor would the preservation of its species be possible, if constant adjustment to the surroundings was not brought about by the agency of the nervous system and sense-organs (see p. 2). This is seen, for example, in the utilitarian significance of pleasure and pain. Pleasure, broadly speaking, promotes actions which conduce to self-preservation and the maintenance of the species, while pain as constantly forbids other actions which would mean self-destruction. Unless pleasure were associated, for instance, with the act of eating, an animal would probably be content to starve, while if contact with burning substances caused no pain it would be very liable to self-cremation. Now there can be no doubt at all that the feelings to which Beauty and Ugliness give rise are simply to be regarded as finer manifestations of pleasure and pain, and since Æsthetics is concerned with such feelings it clearly rests upon a physiological basis.

THE SENSE OF SIGHT AND ITS BEARING ON ÆSTHETICS.—We have only to reflect for a moment on the deprivations suffered by a man blind from birth to realize that artistic enjoyment depends most upon the sense of sight. And our criteria of what is beautiful in colour, form, and movement have largely been evolved with reference to the animal world, including human beings. To mention examples is unnecessary, for the illustration scheme of this work provides them in abundance. But a few generalities are perhaps desirable.

No one will deny that the human colour-sense has been largely educated by the materials which flowers provide. But the exquisite tints and colour-schemes of the floral world are strictly utilitarian with reference to plants themselves, being

simply devices for attracting beneficial insects (see p. 85). To insects, therefore, our æsthetic debt is very large.

The Courtship Colours of Insects, Birds, and some other animals (see p. 143) are also as a rule beautiful to us, and have played no small part in the evolution of our artistic sense. With reference to the animals which display them it is pretty certain that they are purely utilitarian.

Were we similarly to consider the materials upon which our ideas of the beautiful in form and movement are based, we should once more have to acknowledge that the evolution of the æsthetic sense has largely progressed on lines determined by the animal world.

Ugliness in the first instance appears to have been associated with what was harmful or dangerous. The repugnance which most of us feel towards snakes, scorpions, and centipedes is probably part of the legacy which has been handed down to us by our prehistoric ancestors (see vol. iii, p. 370). It is also generally admitted that "warning coloration", which marks undesirable properties in many animals, is crude and inartistic from the human stand-point.

THE SENSE OF HEARING AND ITS BEARING ON ÆSTHETICS.—Next to sight, hearing is the most important sense, from the æsthetic stand-point. The song of birds and the chirp of insects, which further the courtships of their owners (and hence are of utilitarian nature), must have had something to do with the evolution of our standards of what is beautiful in the realm of sound.

THE SENSE OF SMELL AND ITS BEARING ON ÆSTHETICS.—That certain odours are, to our thinking, of fragrant nature, is largely due to the direct or indirect influence which animals have had upon human development. Many species emit strong musky odours, serving for purposes of recognition, and also as courtship accessories. Civet-cats are an example of this, and at one time "civet", obtained from certain glands in these animals, was a favourite perfume, though it would now be considered rank. It has been replaced by musk, obtained from glands possessed by the Musk Deer (*Moschus moschiferus*), though even this perfume is too coarse for cultivated tastes, which show a preference for floral odours. But, as we have elsewhere seen (see p. 85), the delicate scents of flowers are of utilitarian mean-

ing to the plants which possess them, being so many baits to attract useful insects.

One substance used as a sort of basis in the manufacture of perfume, *i.e.* ambergris, is on an entirely different footing from such things as musk or attar of roses, its properties being, so to speak, accidental. It consists of concretions, which are formed in the intestine of the Sperm-Whale as a result of disease.

THE SENSE OF TASTE AND ITS BEARING ON ÆSTHETICS.—The organs of taste were, in the first instance, undoubtedly evolved in relation to food-testing, a purely utilitarian matter. Adaptation to diets of particular kind would have been difficult, if not impossible, without this, and there would also have been a liability to take in poisonous substances. Pleasurable sensations would gradually come to be associated with the taste of desirable food, and sensations of opposite kind with that of unsuitable aliment, to say nothing of poisons.

Tastes pure and simple, such as that of sweetness, do not rank very high in the æsthetic scale, but it is otherwise with "flavours", which are combinations of tastes and odours. The triumphs of the art of cookery, so dear to the gourmand, are of necessity largely based on the properties of animals in the dead state. But this of course is a mere commonplace.

THE EVOLUTION OF ART AND CERTAIN FORMS OF LITERATURE.—In the evolution of Æsthetics, Groos considers that "play" has been a dominant factor. By Spencer (and Schiller before him) play was regarded as a manifestation of surplus energy, an expression of the "joy of life". But Groos interprets the play of animals as being an instinct whereby preparation is given for the stern realities of existence. A kitten, for example, by playing with various objects, including its own tail, acquires fitness for the pursuit of mice. According to this view an animal or young child does not play because it is young, but has a period of youth in order that it may play. Imitation is here of importance in helping the acquisition of powers that will later on be useful. Baldwin regards it as standing between instinct and intelligence, sometimes promoting the preservation of the former, and in other cases enabling it to be more or less discarded in favour of intelligent actions. Groos summarizes his ideas regarding the relation between play and art in the following table, which, though susceptible of criticism, will serve as the basis for a few remarks.

PLAY

Experimentation

(Joy in being able)

(Pretence: conscious self-deception)

Self-exhibition.	Imitation.	Decoration.
The Personal	The True.	The Beautiful.
With animals { Courtship arts.	Imitative arts. Imitative dance.	Building arts. Ornamentation.
With man { Dance with excitement. Music. Lyric poetry.	Pantomime. Sculpture. Painting. Epic Poetry. Drama.	Architecture.

Plenty of examples of each of the three primary groups above are to be found in the animal world. *Self-exhibition* as manifested in Courtship arts is sufficiently illustrated by Birds and Spiders, and some account of it has already been given (see pp. 148 and 166).

No better instance of *Imitation* could possibly be given than the concerted Dances of some birds, graphically described by Hudson (in *The Naturalist in La Plata*). The following is his account of the evolutions of the Spur-winged Lapwing (*Hoplopterus cayanus*, fig. 1283) of South America:—"The lapwing display, called by the natives its 'dance', or 'serious dance'—by which they mean square dance—requires three birds for its performance, and is, so far as I know, unique in this respect. The birds are so fond of it that they indulge in it all the year round, and at frequent intervals during the day, also on moonlight nights. If a person watches any two birds for some time—for they live in pairs—he will see another lapwing, one of a neighbouring couple, rise up and fly to them, leaving his own mate to guard their chosen ground; and instead of resenting this visit as an unwarranted intrusion on their domain, as they would certainly resent the approach of almost any other bird, they welcome it with notes and signs of pleasure. Advancing to the visitor, they place themselves behind it; then all three, keeping step, begin a rapid march, uttering resonant drumming notes in time with their movements; the notes of the pair behind

being emitted in a stream, like a drum-roll, while the leader utters loud single notes at regular intervals. The march ceases; the leader elevates his wings and stands erect and motionless, still uttering loud notes; while the other two, with puffed-out plumage and standing exactly abreast, stoop forward and downward until the tips of their beaks touch the ground, and, sinking their rhythmical voices to a murmur, remain for some time in this posture. The performance is then over, and the visitor

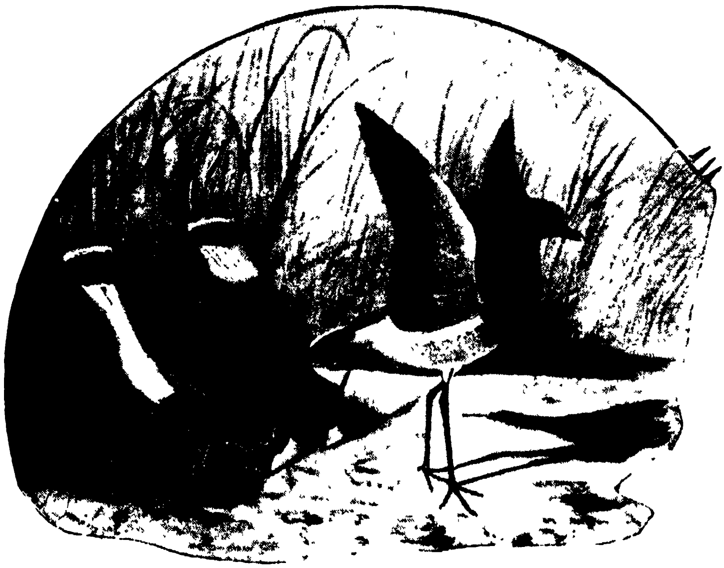


Fig. 1283.—Dance of Spur-winged Lapwings (*Hoplopterus cayanus*)

goes back to his own ground and mate, to receive a visitor himself later on."

As to the third kind of artistic development, placed under the head of *Decoration*, we once more find among Birds the best illustrations. Their nests not only exemplify, in some cases, the art of building carried to a high pitch of perfection (see vol. iii, p. 457), but may also involve a certain amount of decorative skill. Both, however, are most strikingly seen in the curious "runs" made by the Bower-Birds, native to the Australian region. They appear to play some part in courtship, and their original discoverer, Gould, describes them as follows (in *P.Z.S.* 1840):—"These constructions are perfectly anomalous in the architecture of birds, and consist in a collection of pieces of stick or grass, formed into a bower; or one of them (that

of the *Chlamydera*) might be called an avenue, being about 3 feet in length, and 7 or 8 inches broad inside; a transverse section giving the figure of a horse-shoe, the round part downwards. They are used by the birds as a playing-house, or 'run' as it is termed, and are used by the males to attract the females. The 'run' of the Satin-Bird is much smaller, being less than 1 foot in length, and moreover differs from that just described in being decorated with the highly-coloured feathers of the parrot tribe; the *Chlamydera*, on the other hand, collects around its

Fig 1284.—Gardener-Birds (*Amblyornis inornatus*), with hut and garden; male in foreground, female at back.

'run' a quantity of stones, shells, bleached bones, &c.; they are also strewed down the centre within."

Newton thus describes (in *A Dictionary of Birds*) some even more remarkable kinds of Bower-Bird, unknown to science at the time of Gould's observations:—"A bird of New Guinea, . . . *Amblyornis inornatus*, fig. 1284, has been found by Signor Beccari to present not only a modification of bower-building, but an appreciation of beauty perhaps unparalleled in the animal world. His interesting observations . . . show that this species, which he not inaptly calls the 'Gardener' (*Gjardiniere*), builds at the foot of a small tree a kind of hut or cabin (*capanna*) some 2 feet in height, roofed with orchid-stems that slope to the ground, regularly radiating from the central support, which is covered

with a conical mass of moss, and sheltering a gallery round it. One side of this hut is left open, and in front of it is arranged a bed of verdant moss, bedecked with blossoms and berries of the brightest colours. As these ornaments wither they are removed to a heap behind the hut, and replaced by others that are fresh. The hut is circular and some 3 feet in diameter, and the mossy lawn in front of it nearly twice that expanse. Each hut and garden are, it is believed, though not known, the work of a single pair of birds, or perhaps of the male only; and it may be observed that this species, as its trivial name implies, is wholly inornate in plumage. Not less remarkable is the more recently described 'bower' of *Prionodura*, a genus of which the male . . . is conspicuous for his bright orange coloration. This structure is said by Mr. Devis . . . to be piled up almost horizontally round the base of a tree to the height of from 4 to 6 feet, and around it are a number of hut-like fabrics, having the look of a dwarfed native camp."

With the stages in the evolution of human art we are here not directly concerned, but enough has been said to show that a careful study of the habits of animals is likely to throw a good deal of light upon the subject.

ANIMALS AS MATERIAL FOR ART AND LITERATURE.—Animals form such an important part of the environment of man that they naturally figure largely in art and literature. If, in imagination, we entirely eliminate animal forms from galleries of sculpture or pictures we shall realize this very fully, and ideas derived from the animal world are also embodied to some extent in music. As we have elsewhere seen (p. 341), the Tarantella originated with reference to a kind of spider.

The art of decoration is also indebted to the animal world, some of the most beautiful designs being based upon animal forms. Mr. Talwin Morris' "peacock design" on the covers of this book is a particularly charming example.

In literature our debt to animals is no less great. The very letters of the alphabet, which, as everyone knows, are the descendants of Egyptian picture-symbols or hieroglyphs, were in some instances originally based on animal forms. V, for example, represents the last remains of a drawing of the Horned Viper (*Cerastes*) of Egypt (fig. 1285).

Animals make no inconsiderable figure in both prose and

poetry. In fables, from the time of Æsop downwards, they often supply the principal characters. Sterne has immortalized the Starling, Shakespeare and Shelley the Sky-Lark, Poe and Dickens the Raven, Aristophanes and Thoreau the Frog. Other examples are scattered broadcast through the literatures of the world, and to name them would be a work of supererogation. They often supply the *motif* for poetic efforts which express our

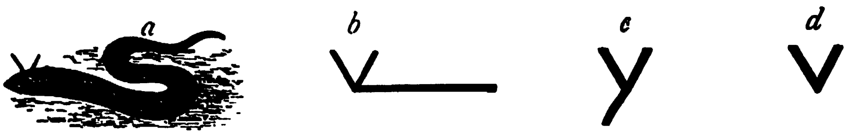


Fig 1285.—Evolution of V. *a*, Egyptian hieroglyphic: *b*, abbreviation of same; *c*, Phœnician form; *d*, final form.

sympathy with Nature, and appeal more particularly to those of us who are counted among the worshippers of "the great god Pan". The poem "Enchanted Tones", by J. S. Welhaven, may serve to illustrate this point, and it will be unknown to most readers, for its native language is Norwegian.

"A bird flew over the pine-clad hill
Of the old, old legends singing,
And carried me out of life's beaten way
Into dreamland's dim beginning.
I came to the moorland's secret spring
Where fairies their thirst were slaking,
But ever those magical notes I heard
'Midst the sighs that the breeze was making.

"I stood in the beech-trees' silver shade
As the sunset rays low slanted,
When glimmered the dew in the darkling glade
And on hill shone like gold enchanted:
Then rustled the branches, a sound drew nigh
As of wings that were rising and falling,
And ever from fell-top, and ever from tree
Those magical flute-notes were calling.

"Away in the woodland, far away,
Is the songster's leafy dwelling,
From under the pine-trees, ever and aye,
His melody's tide is swelling;
And though I never may reach his home,
The song there is no forgetting,
That sounded sweet when eve's dewy wings
Shut soft as the sun was setting."

DISTRIBUTION IN SPACE AND TIME

CHAPTER LXXV

GEOGRAPHICAL DISTRIBUTION

To consider, and so far as possible explain, the way in which animals are now spread over the surface of the globe is the province of Geographical Distribution, or, as it is sometimes called, Zoogeography. Alfred Russel Wallace, more than any other man, has been the means of placing this branch of Natural History on a really scientific footing, and his invaluable works *The Geographical Distribution of Animals* and *Island Life* will long remain standard sources of information on the subject. Smaller books by Heilprin and Beddard (*Geographical and Geological Distribution of Animals*, and *Zoogeography*) will also be found extremely useful by the student.

A good deal of information about the parts of the world to which a number of animals belong has already been given in the preceding sections of this work, but certain facts and principles require special mention here, though only elementary treatment is possible, or, it may be, desirable.

Before the theory of evolution became dominant it was commonly believed that any particular kind of animal found within a certain area was specially created there, and speculation was deemed out of place, though it was assumed that one sort of climate suited certain species, and another sort of climate other species. But we are not now contented with the statement "This is so", and always ask "*Why* is this so?" To which question we sometimes get a fairly satisfactory answer.

Areas of Distribution.—If we consider any kind or species of animal, or any one of the larger groups, such as a genus, a family, an order, or a class, we shall find that it may occupy a limited

or an extensive area, or that it may be found in two or more widely distant parts of the world, and be entirely absent from the intervening regions. The last and perhaps the most interesting case is technically described by speaking of a "discontinuous area of distribution". Believing that existing species have been evolved in course of time from other species, it is pretty obvious that any sort of animal which occupies a restricted area must either have come into existence comparatively recently, or else be an ancient form which has gradually lost ground and is progressing towards extinction. A good example of the latter state of things is afforded by the Tuatara (*Hatteria punctata*), now only to be found on some islets in the Bay of Plenty, off the North Island of New Zealand, upon which larger land-mass we know that it formerly existed. The evidence of geology also proves that it is the last living representative of an order of Reptiles (*Rhychocephala*) which was once widely distributed and dominant, being very likely the parent reptilian group from which all the other orders took origin.

In dealing with questions of distribution it is important to remember that the outlines of land and sea have undergone many changes in the course of the world's history. At various periods, for example, the land-masses of the Old and New Worlds have been connected together in the North, while Australia and the East Indies are the surviving remnants of an extension of the mainland of Asia. Comparatively recent union between land-areas now distinct is often indicated by intervening shallow water, more ancient union by deeper water. From this and other facts we conclude that the British Isles were part of the continent of Europe in comparatively recent times, while many ages have elapsed since Madagascar was continuous with Africa, and the connection of Australia with Asia was still more remote. On the other hand, there are certain small islands isolated in mid-ocean, such as St. Helena and Ascension, which probably never formed part of any existing continent. Using this principle as a basis, Wallace classifies islands as "continental", *e.g.* the British Isles and Madagascar, which once were united with adjacent mainlands; and "oceanic", *e.g.* St. Helena, in which this has never been the case. That such a view explains many of the features of island faunas we shall presently see: the bearing of the former existence of "land-bridges", long since submerged, upon questions

of discontinuous distribution is, for the moment, our immediate concern.

One of the best examples of discontinuous distribution is afforded by the order of Pouched Mammals (*Marsupialia*), now mainly limited to the Australian region, though also represented in America by the Opossums and one other form (*Cœnolestes*). Without the aid of the geological record the reason for this would ever remain a matter of the merest conjecture. We know, however, from the evidence this record affords, that in the remote past Pouched Mammals were common enough in Europe, and there are enough facts upon which to base the view that the earliest representatives of the order were evolved in the land-mass of Eurasia. From this area the Pouched Mammals gradually spread, entering what are now America and Australia over tracts of land since submerged beneath the sea. Elsewhere, owing to the competition of more highly specialized mammals, they have died out. But the Australian region having been cut off from the northern land-mass before the higher mammals had a chance of entering it, the pouched forms of that region had a field free from serious competition, in which have since been evolved numerous species adapted to many diverse modes of life. In America they had a harder struggle for existence, and at the present time are poorly represented there, chiefly by Opossums, the ancestors of which no doubt reached the New World by one or more formerly existing land-bridges in the north. There is also good reason for thinking that South America also received a population of pouched mammals from Australia, by means of a southern land-bridge, of which some existing islands appear to be remnants. This Australian stock has since died out almost entirely, being now only represented by two small species of Opossum-Rats (*Cœnolestes*), native to Colombia and Ecuador.

Discontinuous distribution explained on somewhat different lines is exhibited by the Lung-Fishes (*Dipnoi*), now represented only in the fresh waters of Africa, South America, and Queensland (see vol. i, p. 264). Once more a clue is afforded by the geological record, from which we know that the ancestors of the Lung-Fishes were at one time a dominant and widely distributed *marine* group. Hard pressed by fishes better adapted to life in the sea, some of them took refuge in estuaries, ultimately passing into the fresh waters of the land. It is only these which

in widely distant parts of the world have left descendants, while all the marine types were doomed to extinction.

DISPERSAL OF ANIMALS.—A species which meets with any success in the struggle for existence increases largely in numbers and, led chiefly by the search for food, comes to occupy a tract of land or sea of continually increasing size (*i.e.* it widens its area of distribution) until prevented by natural causes from migrating farther. The means of locomotion possessed by such a species necessarily plays an important part in the matter. The power of flight, for example, often renders wide dispersal possible, as in the case of Bats. But there are usually certain physical barriers which put a stop to the migratory movements of most kinds of animal. Mammals other than Bats are unable to cross even narrow arms of the sea, while mountain chains and deserts often prove potent checks to further advance. And for every other group of land forms obstacles of varying kind present themselves. Even in the case of marine species limits are imposed by temperature, depth of water, supply of suitable food, competition with other species, and so on.

ZOOGEOGRAPHICAL REGIONS OF THE LAND.—It is generally considered that Mammals afford the best means of dividing the land into regions possessing characteristic faunas, and as the areas thus demarcated answer fairly well for Birds, the subdivisions made by W. L. Sclater on this basis, and afterwards adopted by Wallace, will here be given. A reference to the accompanying map (fig. 1286) will show that the boundaries between Sclater's six great regions are largely constituted by physical barriers. Each of these primary subdivisions is again divided into sub-regions. All that can be attempted here is a brief account of the leading features of the large distributional areas, especially with reference to Mammals and Birds. So many incorrect ideas are current, even among educated persons, about the distribution of well-known animals, that no attempt will be made to avoid details that will be commonplace to some readers. Most of the forms of life mentioned in this chapter will be found to have received notice in other connections. It may be well first of all to enumerate the regions and sub-regions.

I. PALÆARCTIC REGION.—Europe,—all but the south of Asia,—and Africa north of the Sahara. Sub-Regions:—1. European; 2. Mediterranean; 3. Siberian; 4. Manchurian.

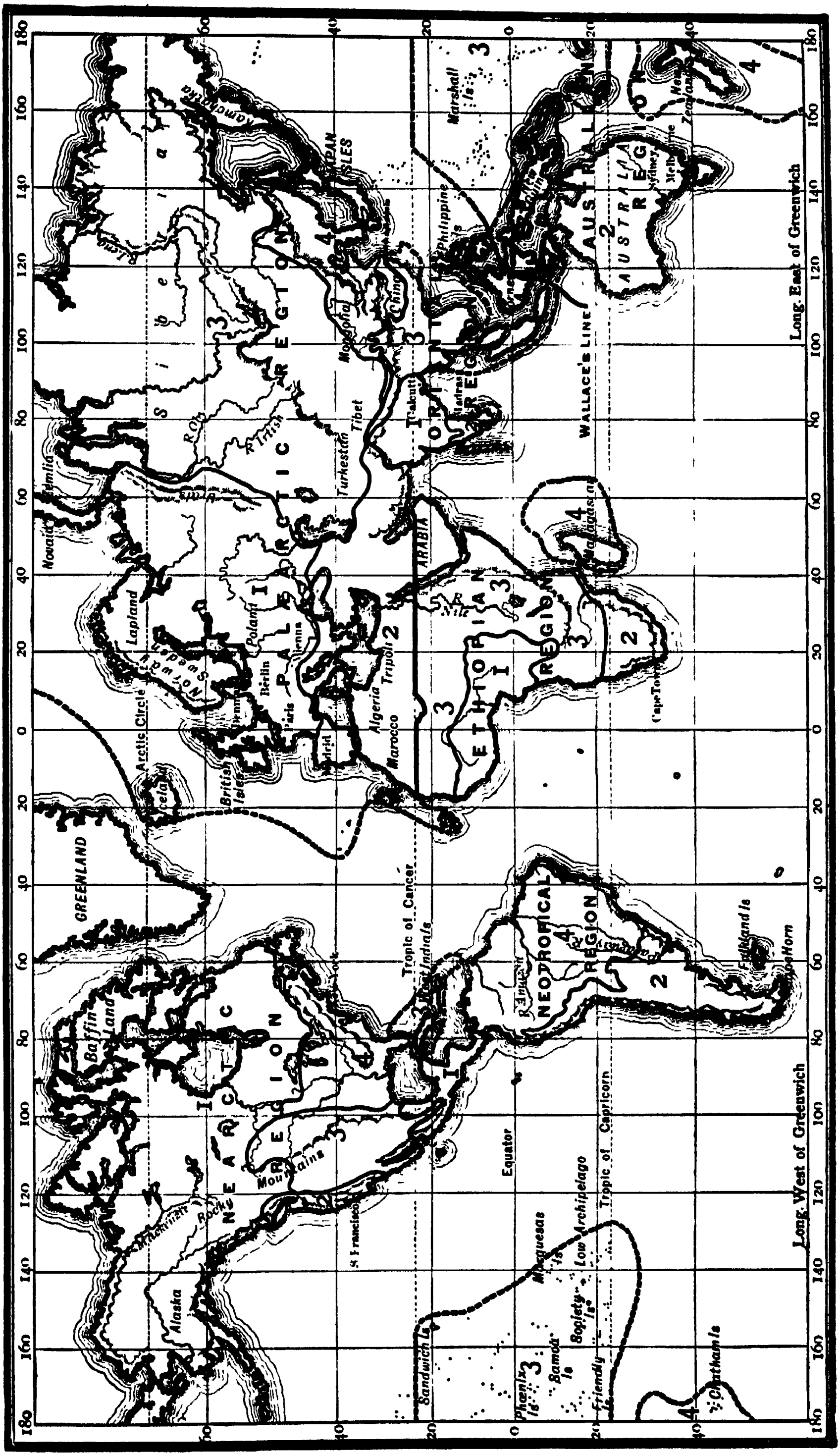


Fig. 1286.—Zoogeographical Regions of the Land. The figures indicate the sub-regions (see text).

II. Nearctic Region. — Practically equivalent to North America. Sub-Regions:—1. Canadian; 2. Californian; 3. Rocky Mountain; 4. Alleghany.

III. Ethiopian.—Africa south of the Sahara, south Arabia, and Madagascar. Sub-Regions:—1. West African; 2. South African; 3. East African; 4. Mascarene.

IV. Oriental Region.—South Asia, the western part of the East Indies, the Philippines, and Formosa. Sub-Regions:—1. Indian; 2. Cingalese; 3. Indo-Chinese; 4. Indo-Malayan.

V.—Australian Region.—The eastern part of the East Indies, Australia and adjacent islands, New Zealand, and Polynesia. Sub-Regions:—1. Austro-Malayan; 2. Australian; 3. Polynesian; 4. Novo-Zelanian.

VI. Neotropical Region.—Central America, South America, and the West Indies. Sub-Regions:—1. Mexican; 2. Chilian; 3. West Indian; 4. Brazilian.

Chalmers Mitchell has devised the following ingenious way of representing the regions and sub-regions in a diagrammatic form, which readily lends itself to expressing the distribution of any animal or group of animals, by simply leaving out the numbers of those sub-regions in which that particular form or group does not occur.

Regions and Sub-Regions.

II	I	
1	1 3	
2 3 4	2 4	
VI	III	IV
1 3	1 3	1 3
		2 4
		V
		1 3
2 4	2 4	2 4

Distribution of Crocodiles and Alligators (Crocodilia).

II	I	
3 4	4	
VI	III	IV
1 3	1 3	1 3
		2 4
		V
		1 3
4	2 4	2

Fauna of the Palæarctic Region.—In spite of its great size this region possesses comparatively few animals which are found nowhere else. The number would be much larger if there were not a good many species common to it and the Nearctic Region. This is not very surprising when we remember the

comparative narrowness of the Behring Straits, across which there was a land-bridge at no very remote period, geologically speaking. At one time, too, Europe and North America were connected by land occupying the North Atlantic, and the sea between Britain and Greenland is still comparatively shallow. It may be objected that even if such unions once existed the rigour of the northern climate would prevent land animals from migrating across them; but we know that there have been many changes in climate during the past history of the globe, and that for part of the time when these land-bridges existed a much higher temperature prevailed in the areas they occupied than is now the case. Besides which, the objection, even if valid, would not apply to Arctic forms; and, further, many animals which we now associate with the warmer parts of the earth are able to endure a larger amount of cold than is sometimes supposed. It may be added that the resemblances between the faunas of the Palæarctic Region and the northern part of North America are so striking that many writers associate these together under the name of the Holarctic Region. This fact is mentioned because in dealing with certain forms it will be convenient to speak of them as being "holarctic".

Palæarctic Mammals (*Mammalia*).—Among Insect-eating Mammals (*Insectivora*) our common Mole (*Talpa Europæa*) and related species of the same genus are confined to this region, as also are the Desmans (*Myogale*), while Hedgehogs (*Erinaceidæ*) are very characteristic, though not peculiar. Of the Flesh-Eaters (*Carnivora*) very few are entirely limited to the region, the most notable being the Raccoon-Dog (*Nyctereutes*, fig. 1287) of north-east Asia, and the Common Badger (*Meles taxus*) with some of its immediate allies. It should be stated, however, that a number of Carnivores are purely holarctic, *e.g.* the Polar Bear (*Ursus maritimus*), the Glutton (*Gulo luscus*), Lynxes, and Arctic Foxes; while some others are very characteristic, *e.g.* Wolves, Bears (other than the Polar species), Martens, and Weasels. Some aquatic Carnivores are entirely holarctic, such as the Sea Otter (*Latax lutris*), the Greenland Seal (*Phoca Grœnlandica*), the Walrus (*Trichechus rosmarus*), and the Greenland Whale (*Balæna mysticetus*).

The Palæarctic region is comparatively rich in Hoofed Mammals (*Ungulata*) native to no other part of the world. Among these are conspicuous typical Oxen (*Bos*), Goats (*Capra*),

and Sheep (*Ovis*), which are hardly represented elsewhere; also a number of Deer (*Cervidæ*), such as the Fallow-Deer (*Dama vulgaris*), Roe-Deer (*Cervus capreola*), and Water-Deer (*Hydropotes*); while, besides these, certain Antelopes, such as the Chamois (*Rupicapra tragus*) and the Saiga Antelope (*Saiga Tartarica*), are peculiar. Nor must mention of the Camels

Fig. 1287.—Raccoon Dog (*Nyctereutes*)

(*Camelus*) be omitted. The Reindeer (*Rangifer tarandus*), Elk (*Alces machlis*), and Musk-Ox (*Ovibos moschatus*) may be mentioned as typically holarctic Ungulates.

Among Gnawing Mammals (*Rodentia*), Dormice (*Myoxus*) and Mole-Rats (*Spalax*) are Palæarctic, while Marmots (*Arctomys*) and 'Calling Hares or Pikas (*Lagomys*) are holarctic. Beavers (*Castor*), Voles (*Microtus*), Ground-Squirrels (*Tamias*), and most of the Hares and Rabbits (*Lepus*) are also holarctic.

Palæarctic Birds (*Aves*).—Among the genera which are limited to this region are some of those including a number of our familiar British forms, *e.g.* Grasshopper Warbler (*Locustella*), Robin Redbreast (*Erithacus*), "Bearded Tit" or Reedling (*Panurus*), Long-tailed Tit (*Acredula*), Buntings (*Emberiza*), Chaffinch (*Fringilla*), Bullfinch (*Pyrrhula*), Jay (*Garrulus*), Nutcracker (*Nucifraga*), and Partridge (*Perdix*). Ordinary Pheasants (*Phasianus*) and some of their more ornamental relatives are also very characteristic Palæarctic forms. Some other British birds belong to holarctic genera, *e.g.* Red Grouse and Ptarmigan (*Lagopus*), Capercailzie (*Tetrao*), Divers (*Colymbus*), Razor-Bills (*Alca*), Guillemots (*Uria*), and Puffins (*Fratercula*).

Palæarctic Reptiles (*Reptilia*).—A solitary species of Alligator (*Alligator Sinensis*) is native to South China. Our indigenous Blind-Worm represents a purely Palæarctic genus (*Anguis*) of limbless lizards, while that (*Lacerta*) which includes the Sand-Lizard, Green-Lizard, and Wall-Lizard is hardly represented outside the region.

Palæarctic Amphibians (*Amphibia*).—Peculiar to this region are the genera including the Fire-bellied Toads (*Bombinator*), that form (*Alytes*) in which the male carries about the egg-masses, and the Salamanders (*Salamandra*). It is also interesting to notice that the great majority of Tailed Amphibians (*Urodela*) are limited to the Northern Hemisphere.

Palæarctic Fishes (*Pisces*).—Among British freshwater fishes, Carp and Tench may be mentioned as representing genera (*Cyprinus* and *Tinca*) peculiar to the region, as also are the Gold-fishes, &c. (*Carassius*), of China and Japan. There are also some families of fishes which are very characteristic of the Northern Hemisphere, *e.g.* those containing Pikes (*Esocidæ*), Sticklebacks (*Gasterosteidæ*), and Salmon (*Salmonidæ*). Most of the curious archaic Ganoids (*Ganoidei*) also belong to the same hemisphere. These forms (see vol. i, p. 266) present a good example of a discontinuous area of distribution to be explained in the same way as that of the Lung-Fishes (see p. 266).

Palæarctic Insects (*Insecta*).—Perhaps the most striking feature of the region is the great abundance of predaceous Ground-Beetles (*Carabidæ*) which it possesses, regarding which Wallace says (in *Island Life*) that ". . . the large and handsome genus Carabus, with its allies Procerus and Procrustes, contain-

ing nearly 300 species, is almost wholly confined to this region, and would alone serve to distinguish it zoologically from all other parts of the globe".

FAUNA OF THE NEARCTIC REGION.—It will be remembered that the "holarctic" forms already mentioned are common to the Palæarctic region and northern part of the Nearctic region, and need not, therefore, be mentioned again, though it may be well to state that the Musk-Ox (*Ovibos*) is almost entirely Nearctic.

Fig. 1288.—Star-nosed Mole (*Condylura*)

Nearctic Mammals (*Mammalia*).—Among the Insect-Eaters (*Insectivora*) the Star-nosed Mole (*Condylura*, fig. 1288) is the most remarkable of the purely Nearctic forms. A number of the Flesh-Eaters (*Carnivora*) differ from those of the Old World, but as the most important of these are even more characteristic of the Neotropical region, mention of them will be postponed. Two of the Hoofed Mammals (*Ungulata*) are essentially Nearctic, *i.e.* the Pronghorn (*Antilocapra*) and the Rocky Mountain Goat (*Haploceros*). Two families of Gnawers (*Rodentia*) are confined to this region, the Pouched Rats (*Saccomyidæ*), including Gophers, Kangaroo-Rats, and Pocket-Mice, and the Sewellels (*Haplodontidæ*), including two species of small rodents allied to the squirrels but with the habits of marmots. Besides these, two very typical Nearctic genera belong to this order, *i.e.* those to which the Tree-Porcupine (*Erethizon*) and the Prairie-Dogs (*Cynomys*) belong. Opossums (*Didelphyidæ*) represent the Pouched Mammals (*Marsupialia*) in this region, but are more typical of the Neotropical.

Nearctic Birds (*Aves*). — Many of the familiar Palæarctic

species are replaced by members of characteristic American families. There are also a number of peculiar Nearctic genera, but to give a list of them would serve no useful purposes. Turkeys (*Meleagris*) are well represented, but also range south into Central America.

Nearctic Reptiles (*Reptilia*).—It need only be said that poisonous Lizards (*Heloderma*) are characteristic, as also are Rattlesnakes (*Crotalus*), though both range into the Neotropical region, while Crocodiles and Alligators are represented in the south of the United States.

Nearctic Amphibians (*Amphibia*).—The region is richer than any other part of the world in Tailed Amphibians (*Urodela*), and among the peculiar forms are the curious Mud-Eels (*Amphiuma*) and Sirens (*Siren*).

Nearctic Fishes (*Pisces*).—Several families and a considerable number of genera of freshwater fishes are native to this region only, but their names would convey little meaning to average European readers.

Nearctic Freshwater Molluscs (*Mollusca*).—Wallace states that the Nearctic region is richer in characteristic forms than any other part of the world.

Fauna of the Ethiopian Region.—We have seen that the approximation in high latitudes of the great land-masses of the Northern Hemisphere has led to a great deal in common between the faunas of the Palæarctic and Nearctic regions, and both of them are rather deficient as regards the presence of peculiar forms known to the lay reader. This renders it rather difficult to treat them in a popular manner; but there is no such difficulty with regard to the southern regions which remain for consideration, as all of them have well-marked characteristics, and their more typical animals are familiar to everyone. In varying degree they have been more or less isolated by physical barriers for very long periods of time, and this isolation has rendered possible the evolution of distinctive faunas.

Ethiopian Mammals (*Mammalia*).—There is no lack of Apes and Monkeys (*Primates*) belonging to genera not represented elsewhere. Among the higher or man-like Apes the Gorilla (*Gorilla*) and Chimpanzee (*Anthropopithecus*) are typical, while of lower forms may be mentioned the Colobi (*Colobus*) with reduced thumbs, the Guenons (*Cercopithecus*), and a number of

Baboons (*Papio* or *Cynocephalus*). The majority of Lemurs (*Lemuroidea*) are African. The peculiar Ethiopian Insect-Eaters (*Insectivora*) include the Golden Moles (*Chrysochloris*), and an otter-like West African form (*Potamogale*), among many other characteristic types. There are also Flesh-Eaters (*Carnivora*) belonging to purely Ethiopian genera, *e.g.* the Foussa (*Cryptoprocta*) of Madagascar, the Aard-Wolf (*Proteles*), and the Cape Hunting-Dog (*Lycaon*). Though Lion (*Felis leo*)

Fig. 1289.—Wart-Hog (*Phacochœrus*)

and Leopard (*F. leopardus*) are both very characteristic, the former ranges into Asia (and has only become extinct in Europe during historic times), while the latter so closely resembles the Asiatic Panther (*F. panthera*) that the two animals are often considered as belonging to the same species. A curious negative feature is found in the complete absence of animals of the Bear kind. Of Hoofed Mammals (*Ungulata*) many remarkable forms are limited to the Ethiopian region. They include Zebras (species of *Equus*), characteristic species of Rhinoceros, Wart-Hog (*Phacochœrus*, fig. 1289), Red River-Hog (*Potamochœrus*), Hippopotamus (*Hippopotamus*), the Giraffe (*Giraffa*), Okapi (*Okapia*), a number of Antelopes, and the little Water-Chevrotain (*Dorca-*

therium). Deer and wild Oxen are absent. Gnawers (*Rodentia*) are represented by a number of peculiar forms, of which may be mentioned the Cape Jumping-Hare (*Pedetes*) and the African "Flying"-Squirrels (*Anomalurus*). The archaic order of Mammals Poor in Teeth (*Edentata*) is represented by the Cape Ant-Eater or Aard-Vark (*Orycteropus*), and Pangolins (*Manis*), though the latter are shared with the Oriental region.

Ethiopian Birds (*Aves*).—Among the many peculiar forms it may suffice to mention Plantain-Eaters (*Musophaga*), Colies (*Colius*), Whydah Finches (*Vidua*), Ox-Peckers (*Buphaga*), many of the beautiful little Sun-Birds (*Nectariniidæ*), the Secretary-Bird (*Serpentarius*), and the African Ostrich (*Struthio*).

Ethiopian Reptiles (*Reptilia*).—Crocodiles are abundant but not peculiar, while among Lizards (*Lacertilia*) the large majority of the Chameleons are limited to the region. Among the innumerable Serpents (*Ophidia*) the Egg-eating Snake (*Dasypeltis*) and deadly Puff-Adders (*Bitis*) are purely Ethiopian.

Ethiopian Amphibians (*Amphibia*).—The Clawed Toads (*Xenopus*) are limited to Africa, while, on the other hand, not only are Tailed Amphibians (*Urodela*) entirely absent, but also several families of Tailless Amphibians (*Anura*), *e.g.* the Tree-Frogs (*Hylidæ*).

Ethiopian Freshwater Fishes (*Pisces*).—Some of the most archaic types are limited to the region, *e.g.* one of the Lung-Fishes (*Protopterus*), the Bichir (*Polypterus*), and the Reed-Fish (*Calamoichthys*), the last two being Ganoids.

Ethiopian Land and Freshwater Molluscs (*Mollusca*).—One of the large Land-Snails (*Achatina*) is very characteristic, though not limited to Africa, while Land-Slugs are comparatively scarce, and freshwater molluscs are less abundant than in some other regions. The fauna of Lake Tanganyika presents some remarkable features. As we have seen elsewhere (see p. 313) the Caspian Sea and Lake Baikal were once continuous with the Arctic Ocean, the fact that each is inhabited by a peculiar species of Seal being accounted for in this way. It appears that in remote geological times Tanganyika was also part of a sea area, and was converted into a lake as one of the results of a series of land-upheavals. Some of the marine molluscs and other animals living in the sea of which it formed a part proved able to accommodate themselves to the altered conditions, and

these "halolimnic" forms, some to all appearance closely resembling ancient extinct types, are now found in the fresh waters of this lake, side by side with ordinary freshwater species.

Ethiopian Insects (*Insecta*).—The region is very rich in insect life, but it is not possible here to enter into details regarding the many interesting and beautiful species. Wallace mentions the large and handsome Goliath-Beetles as being especially characteristic, and some of the complex societies of African Termites have been spoken of elsewhere (see p. 124).

FAUNA OF MADAGASCAR.—This subdivision of the Ethiopian region calls for a few remarks, since it is one of the best existing examples of an ancient continental island connected in remote times with the adjacent continent. There can be no doubt that a large part of the Mascarene fauna has been derived from the mainland of Africa, but Madagascar became isolated at a time when that continent did not include among its inhabitants many of the animals by which it is now characterized. Long-standing isolation has also resulted in the evolution of many peculiar species, some of highly remarkable kind. Both the positive and the negative characters of the Mascarene fauna are best illustrated by reference to the Mammals and Birds.

Mascarene Mammals (*Mammalia*).—Of the sixty-six species of Mammals native to Madagascar about half are Lemurs (*Lemuroidea*), representing no less than nine peculiar genera (*Lemur*, *Chirogaleus*, &c.), of which one (*Chiromys*) includes the remarkable Aye-Aye. Except for about fourteen small species shared between the continent of Africa and the Oriental region, these ill-defended creatures are found nowhere else, and their abundance in Madagascar is no doubt to be attributed to the scarcity of carnivores in that island. The case is on a par with that of the Pouched Mammals of Australia. With the single exception of a Shrew, all the Insect-Eaters (*Insectivora*) of Madagascar belong to the peculiar family of Tanrecs (*Centetidæ*), while the few Gnawers (*Rodentia*) are rats and mice, all belonging to distinctive genera. Flesh-Eaters (*Carnivora*) are only represented by the Foussa (*Cryptoprocta*) and eight kinds of Civet-Cat., Of Hoofed Mammals (*Ungulata*) there is only a species of River-Hog (*Potamochœrus*), although the Hippopotamus is known to have been once indigenous. The characteristic Apes and Monkeys, most of the Flesh-Eaters and Hoofed

CHARACTERISTIC ANIMALS OF THE ISLAND OF MADAGASCAR

Madagascar is a good type of "ancient continental islands" that in remote times were connected with the adjacent continents, which they broadly resemble in the nature of their fauna, though the separation has been long enough to render possible the evolution of peculiar species. The Mascarene animals find their nearest allies on the mainland of Africa, the characteristic monkeys, carnivores, ungulates (with one exception), elephants, and ostriches of which are, however, absent. Half the Mammals (33) of the island are Lemurs, one of the most remarkable of which is the Aye-aye (*Chiromys Madagascariensis*, 1), formerly mistaken for a Rodent. A Mouse-Lemur (*Chirogaleus pusillus*) is represented at 2. Most of the Insectivores, of which the Tenrec (*Centetes ecaudatus*, 3) is best known, belong to a family (*Centetidæ*) represented nowhere else.

Of about 150 species of land-birds no less than 127 are peculiar. The two figured are a Fruit-Pigeon (*Alectorœnas pulcherrima*, 4), native to the Seychelles (which belong to the Mascarene sub-region), and a form (*Philepitta jala*, male, 5) related to the so-called "Ground-Thrushes" or Pittas, but constituting with another Mascarene species a special family (*Philepittidæ*).

CHARACTERISTIC ANIMALS OF THE ISLAND OF MADAGASCAR

1. Aye-aye. 2. Mouse Lemur. 3. Tenrec. 4. Fruit-Pigeon. 5. Philepitt.

Mammals, and also the Elephants of the African continent are conspicuous by their absence.

Mascarene Birds (*Aves*).—The power of flight possessed by most members of this class to a large extent prevents the evolution of peculiar species by isolation, and we must not therefore expect the land-birds of Madagascar to be so characteristic as the mammals, though it is sufficiently striking to find that out of 238 species no less than 129 are limited to the island, and these include representatives of 35 peculiar genera. We may take as examples two species (of *Philepitta*) of great beauty, allied to the Ground-Thrushes, though constituting a distinct family, and four kinds of Fruit-Pigeon belonging to a genus (*Alectoroœnas*) only represented in Madagascar and some of the smaller islands of the sub-region.

FAUNA OF ST. HELENA.—This typical oceanic island, 1100 miles distant from Africa and 1800 miles from South America, may be taken here as a good illustration of its class. Never having formed part of a continent its indigenous fauna naturally presents a strong contrast with that of Madagascar, being entirely made up of such forms of life as have been able to reach it by natural agencies. And since a broad stretch of sea is an insuperable barrier to animals of many kinds, the faunistic characters of St. Helena are largely negative, as in all other such cases. On the other hand, the effect of isolation has been very great, and a large proportion of the species are peculiar.

St. Helena possesses no native Mammals, Land Birds, Reptiles, Freshwater Fishes, or Freshwater Molluscs. There is, however, one peculiar species of Plover (*Ægialitis Sanctæ-Helenæ*) allied to one native to South Africa. Of Land-Snails twenty appear to be indigenous, if we include thirteen that have become extinct in recent times. The Beetles (*Coleoptera*) of the island have been studied with greater care than any other group of insects, and 129 species are native to the island, to which all except one of them are absolutely restricted. More than two-thirds of these beetles are weevils, and, considering the boring habits of such creatures, it is highly probable that the remote ancestors of many of them were conveyed to St. Helena by the agency of drift-wood.

There can be no doubt that many of the animals originally native to this island have become extinct as the result of human

occupation, the introduction of goats having had much to do with this (see p. 346).

FAUNA OF THE ORIENTAL REGION.—The boundaries between this region and the Palæarctic area are in part ill-defined, which naturally means the possession of a number of species in common. The south-eastern boundary, marking it off from the Australian region, is usually known as "Wallace's line", which runs between Bali and Lombok, and thence northwards between Borneo and Celebes. Bali and Borneo thus mark the limit of the Oriental region in this direction.

Oriental Mammals (*Mammalia*).—Taking first the Apes and Monkeys (*Primates*), we find that the higher or man-like Apes are shared between this and the Ethiopian region, for while the Gorilla and Chimpanzee are peculiar to the latter, the Orang-utan (*Simia*) and Gibbons (*Hylobates* and *Siamanga*) are purely oriental. The Proboscis Monkey (*Nasalis*) is restricted to Borneo, while Entellus Monkeys, &c. (*Semnopithecus*), with Bonnet Monkeys and their immediate allies (*Macacus*), mostly belong to this region. It is also the home of three species of Lemur, two of the Loris (or "Slow" Lemurs), and the little Spectre Tarsier. Of the first, one (*Loris*) is restricted to South India and Ceylon, while the other (*Nycticebus*) ranges into the Philippines. The Spectre Tarsier (*Tarsius spectrum*), though chiefly oriental, is also found in Celebes. Two peculiar families of Insect-Eaters (*Insectivora*) are purely oriental, one including the Banxrings or Tree-Shrews (*Tupaiidæ*, fig. 1290), while the only representative of the other is the remarkable Flying-"Lemur" (*Galeopithecus*). There are also two peculiar genera (*Hylomys* and *Gymnura*) of the hedgehog kind. Among Bats (*Chiroptera*) the large Fruit-Bats (*Pteropus*) are characteristic, though not peculiar. Among Flesh-Eaters (*Carnivora*) the Tiger (*Felis tigris*), though very typical, also ranges into North China; but there are a number of peculiar genera belonging to various carnivorous families, while Bears are not absent, as in the Ethiopian region. The Hoofed Mammals (*Ungulata*) are abundantly represented, and some of them are found nowhere else, *e.g.* the little Chevrotains (*Tragulus*, represented in West Africa by *Dorcatherium*), the small Deer known as Muntjacs (*Cervulus*), and certain Antelopes (*Antilope* and the four-horned *Tetraceros*). Rhinoceroses and Elephants (*Proboscidea*) are shared

between this region and Africa. Tapirs (*Tapirus*) are only to be found here and in the Neotropical area. Of Gnawers (*Rodentia*) the most notable are perhaps the Asiatic Flying-Squirrels (*Pteromys*). Mammals Poor in Teeth (*Edentata*) are represented by some of the Pangolins (*Manis*), though some of these are also native to Africa.

Oriental Birds (*Aves*).—Two families of Perching Birds are confined to the region, *i.e.* the Green Bulbuls (*Phyllornithidæ*) and the Broadbills (*Eurylæmidæ*); while some of the many peculiar genera include such better-known forms as the Tailor-Birds (*Orthotomus*), typical Hornbills (*Buceros*), Peacocks (*Pavo*), Peacock-Pheasants (*Polyplectron*), Silver Pheasants (*Gennæus*) and related species, and the Water-Pheasant (*Hydrophasianus*). Highly characteristic, though not entirely limited to this region, are the Jungle-Fowl (*Gallus*).

Fig 1290 —Tree-Shrew

Oriental Reptiles (*Reptilia*).—Crocodiles (*Crocodilus*) are abundant in the region, and the long-snouted Garials (*Garialis* and *Rhynchosuchus*) are limited to it. Of the numerous Lizards (*Lacertilia*) the pretty little Flying Dragons (*Draco*) are purely oriental. The burrowing Shield-tailed Snakes (*Uropeltidæ*) are found in no other region; and the same is true for one genus (*Bungarus*) of poisonous serpents, including the Krait, which is supposed to work more havoc among the natives of India than any other creature of its kind.

Oriental Amphibians (*Amphibia*).—Though tailed forms (*Urodela*) are represented they are vastly outnumbered by the tailless ones (*Anura*), but none of these call for special mention.

Oriental Freshwater Fishes (*Pisces*).—Most of the Snake-headed Fishes (*Ophiocephalidæ*), which are able to live during the dry season in liquid mud, are limited to the region, and the same is true of the members of a small family (*Mastacembelidæ*) of eel-like forms, which, however, have nothing to do with the true eels.

Oriental Insects (*Insecta*).—Regarding these Wallace remarks (in *Island Life*):—"Among insects we may notice the magnificent golden and green Papilionidæ [*i.e.* Swallow-tail Butterflies] of various genera as being unequalled in the world; while the great Atlas Moth is probably the most gigantic of Lepidoptera, being sometimes 10 inches across the wings, which are also very broad. Among the beetles the strange flat-bodied Malayan Mormolyce is the largest of all the Carabidæ [*i.e.* predaceous ground-beetles], while the Catoxantha is equally a giant among the Buprestidæ. [The beautiful wing-covers of various species of this family are largely used in India for ornamental purposes.] On the whole, the insects of this region probably surpass those of any other part of the world, except South America, in size, variety, and beauty."

FAUNA OF THE AUSTRALIAN REGION.—"Wallace's line" (see p. 413), which divides this region from that last considered, is not the sharply-marked boundary that was at one time supposed, for a considerable number of oriental forms range to the east of it, and Australian forms to the west of it. Some authorities consider that the line should be drawn to the east of Celebes, which would then belong to the oriental region. Wallace's line, if thus amended, would be a somewhat sharper boundary than it is now. New Zealand, too, possesses such well-marked positive and negative features that it should possibly be considered as a distinct (Novo-Zelanian) region, instead of being ranked merely as a sub-region. A few of its peculiarities will be indicated in the following brief sketch.

Australian Mammals (*Mammalia*).—Among the animals found in Celebes are three belonging to peculiar genera, *i.e.* a Black Ape (*Cynopithecus*), a Dwarf Ox (*Anoa*), and the Babirussa (*Porcus* or *Babirussa*, fig. 1291), a curious pig-like form with long curled tusks in the upper jaw. It is also inhabited by a species

of Deer, a Civet-Cat, and five kinds of Squirrel, while the Spectre Tarsier (*Tarsus spectrum*) is said to be found on a small adjacent island. The Deer and Civet-Cat have possibly been introduced. Typical Pigs (*Sus*) range as far east as New Guinea, but with this exception, various Bats, a number of rats and mice, and the doubtfully indigenous Dingo (*Canis dingo*) of the Australian continent, the mammalian fauna of the region (excluding Celebes) is made up of Marsupials (represented in Celebes) and Egg-

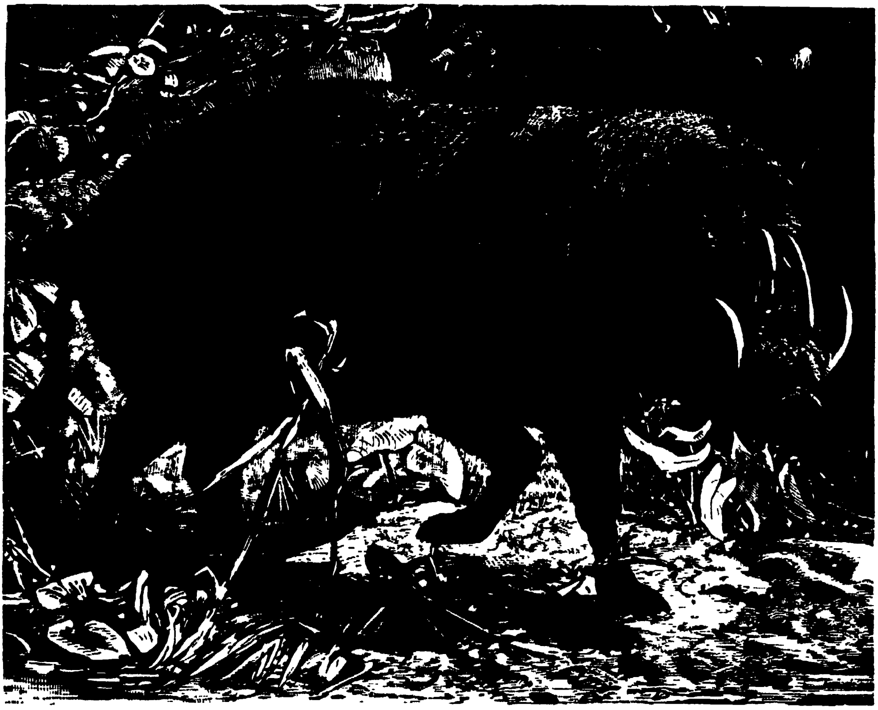


Fig. 1291.—Babirussa (*Babirussa*)

laying Mammals (*Monotremata*). The last, which include the Duck-Bill (*Ornithorhynchus*) and Spiny Ant-eaters (*Echidna* and *Proechidna*), are found in no other part of the world, though Marsupials are scantily represented in America. New Zealand is singularly devoid of indigenous mammals, there only being two peculiar species of bat, a doubtful rat, and a problematical otter-like creature.

Australian Birds (*Aves*).—Among the most typical Australian groups are the beautiful Honey-Suckers (*Musiphagidæ*), many distinctive kinds of Parrot and Cockatoo, Birds of Paradise,

Crowned Pigeons, the land Kingfisher (*Dacelo*) familiarly known as the "Laughing Jackass", the "More-Pork" birds (*Podargus*), the Mound-Builders, Cassowaries, and Emus. All these, except Honey-Suckers, Parrots (not Cockatoos), and Pigeons, are represented in New Zealand, but the other birds named are absent. There are, however, some highly peculiar Novo-Zelanian forms, found in no other area. These include the Kea and Kaka Parrots (*Nestor*), the ground-dwelling Owl-Parrot (*Stringops*), and the Kiwi (*Apteryx*), which is the smallest existing representative of the Running Birds (*Ratitæ*). But within the period of human occupation a number of large species of the last-named group existed in the islands, *i.e.* the "Moas" (*Dinornithidæ*), some of which were over 10 feet in height.

Australian Reptiles (*Reptilia*).—Crocodiles range across the northern part of the region as far east as the Solomon and Fiji Islands. Among the numerous Lizards two peculiar to the Australian continent deserve mention, *i.e.* the Frilled Lizard (*Chlamydosaurus*), which can run for some distance on its hind-legs, and the spiny Mountain Devil (*Moloch*). Snakes are found in abundance, but details are unnecessary. New Zealand possesses a number of Lizards (*Geckoes* and *Skinks*), but neither Crocodiles nor terrestrial Snakes. Some small islands in the Bay of Plenty are, however, of peculiar interest, for they are the home of the Tuatara (*Hatteria*), which is the last surviving member of an exceedingly ancient and once widely distributed reptilian order (*Rhynchocephala*), that was very probably ancestral to all the other known groups.

Australian Amphibians (*Amphibia*).—Tailless forms (*Anura*) are well represented in the region, but New Zealand has only one indigenous species of amphibian, a sort of Toad (*Liopelma*).

Australian Fishes (*Pisces*).—The most interesting species native to this region is Ceratodus, a Lung-Fish (*Dipnoi*) now limited to Queensland.

Fauna of the Neotropical Region.—Although the results of isolation are not here quite so well marked as in the case of Australia, to say nothing of New Zealand, the fauna of the region presents many well-marked characteristics, both positive and negative. It affords a refuge to certain archaic forms, which have been able to prolong the tenure of their existence in the absence of large numbers of carnivores, and, for the same reason,

may be regarded as the head-quarters of some other animals which, though not decadent, are comparatively defenceless. On the other hand, the region stands unsurpassed for variety and wealth of life, which is partly due to its unparalleled range in latitude and diversity in altitude. Every kind of climate and environment are exemplified, from the tropical forests of Brazil to the rigour of the high Andes or Tierra del Fuego, from the grassy pampas of the Argentine to the Patagonian desert.

Neotropical Mammals (*Mammalia*).—To this region are absolutely confined the American Monkeys (*Cebidæ*) and the Marmosets (*Hapalidæ*), both (especially the latter) of lower grade than their Old World cousins. Lemurs (*Lemuroidea*) are entirely absent, as from America in general. There are no fruit-eating Bats (*Pteropidæ*), but a number of genera are peculiar to the region, especially those including the blood-sucking Vampires (*Desmodus* and *Diphylla*). A somewhat remarkable negative feature of the Neotropical fauna is the almost complete absence of Insect-Eaters (*Insectivora*). The widely distributed Shrews (*Soricidæ*) are, however, represented in Central America, while the Agoutas (*Solenodon*) of Cuba and Hayti constitute a distinct family.

Of the most predaceous Flesh-Eaters (*Carnivora*), *i.e.* the members of the Cat Family (*Felidæ*), there is a decided scarcity, the three largest indigenous species—Puma (*Felis concolor*), Jaguar (*F. onca*), and Ocelot (*F. pardalis*)—also ranging into North America. The Civet Cat Family (*Viverridæ*) is entirely unrepresented; while of Bears (*Ursidæ*) there is only the Spectacled Bear (*Ursus ornatus*) of Peru and Chili. Weasels (*Mustelidæ*) and creatures of the Dog Family (*Canidæ*) are fairly abundant. On the other hand, the Neotropical region is the head-quarters of the almost purely American family of Raccoons (*Procyonidæ*) and their allies. The Kinkajou (*Cercoleptes*) is limited to the region, the long-snouted Coatimundis (*Nasua*) range as far north as Texas, while the Raccoons (*Procyon*) have a wide distribution in the New World. One member of this family is native to the Old World, *i.e.* the Panda (*Ælurus*) of the south-eastern Himalayas, and we have here therefore a good example of discontinuous distribution.

The positive and negative characteristics of the region as regards Hoofed Mammals (*Ungulata*) are both well marked.

The Odd-toed Ungulates (*Perissodactyla*) are only represented by the archaic Tapirs (*Tapirus*) of South and Central America. They are one of the stock examples of discontinuous distribution, being also found in south-east Asia. As in many similar cases they are the last surviving representatives of a once widely distributed group (compare p. 410). There is also a scarcity of Even-toed Ungulates (*Artiodactyla*), for of non-ruminants there are only the little Peccaries (*Dicotyles*), which differ in many ways from the Swine of the Old World. They also range into the south of the Nearctic region. Among the Ruminants or Cud-Chewers (*Ruminantia*) the Deer Family (*Cervidæ*) is represented by a number of species belonging to two genera exclusively American. One of these (*Padus*) only includes a very small form (*P. humilis*), native to the Chilian Andes, and of which the male possesses tiny spikes by way of antlers. Most of the species belonging to the other genus (*Cariacus*) are restricted to the Neotropical region, but the largest forms, *e.g.* Virginian and Mule Deer, which also have the most complex antlers, are Nearctic. The large family (*Bovidæ*) embracing Sheep, Goats, Antelopes, and Oxen, which has but few representatives in the Nearctic region, here has none at all. The Camels of the Old World are also absent, but the Guanaco (*Lama guanacus*) and Vicuñia (*L. vicunia*) belong to the same family (*Camelidæ*), and furnish another typical example of discontinuous distribution.

Gnawers (*Rodentia*) are extremely numerous in the Neotropical region, and among peculiar forms may be noted the Cavies (*Caviidæ*), which include the largest existing Rodent (*Hydrochærus capybara*), the Agoutis (*Dasyproctidæ*), and the Chinchillas (*Chinchillidæ*). The archaic and decadent order of Mammals Poor in Teeth (*Edentata*) is also better represented here than anywhere else, for typical Ant-eaters (*Myrmecophagidæ*), Sloths (*Bradypodidæ*), and Armadilloes (*Dasypodidæ*) are only to be found in South America. As to Pouched Mammals (*Marsupialia*), the Opossums (*Didelphyidæ*) are native to both Americas, while the Opossum Rats (*Cœnolestes*) belong to Colombia and Ecuador.

Neotropical Birds (*Aves*).—The region stands unsurpassed for the richness and variety of its avifauna, while a great many families and genera are represented nowhere else, and some of the most distinctive forms are only shared with the Nearctic area.

THE GREAT ANT-EATER (*Myrmecophaga jubata*)

The southern land-masses constitute the last refuge of a number of archaic groups, among which are the Mammals poor in Teeth (*Edentata*), that are most abundantly represented in South America. The plate represents the Great Ant-eater (*Myrmecophaga jubata*), one of the most remarkable Edentates native to that continent. If the long tail is included, its total length may be over 7 feet. The digits of the inwardly turned fore-feet are armed with long sharp claws, well adapted for tearing open ant-hills, and also serving as formidable defensive weapons. The small mouth is placed at the end of a long narrow snout, and the jaws are toothless. Ants are secured by means of the long protrusible tongue, which is made sticky by the abundant secretion of enormous salivary glands. The Great Ant-eater is a ground-animal, but some of its immediate relatives are small arboreal creatures.

THE GREAT ANT-EATER (MYRMECOPHAGA JUBATA)

ONE OF THE MOST REMARKABLE ANIMALS OF SOUTH AMERICA

Of Perching Birds (*Passeres*) a number of families are peculiar, and of these the following are among the most typical:—Manakins (*Pipridæ*), small birds which resemble the Tits in appearance and habits. The large family of Chatterers (*Cotingidæ*), which include the Umbrella-Bird (*Cephalopterus ornatus*), so named from its large overhanging crest of feathers, and the clear-toned Bell-Bird (*Chasmorhynchus*). The Tree-Creepers or Picucules (*Dendrocolaptidæ*) vary remarkably in appearance and in the nature of their nests (see vol. iii, p. 463), while some of the insectivorous Ant-Thrushes (*Formicariidæ*) give notice by their twittering of the approach of armies of Foraging Ants (*Ecitons*). We have also the American "Orioles" (*Icteridæ*), among which are the Cow-Birds (*Molobrus*), some of which, like Cuckoos, lay their eggs in the nests of other species (see p. 186). The true "singing birds" (*Oscines*) of the Old World are comparatively ill represented in this region, the feathered inhabitants of which appeal more to the eye than the ear. Thrushes, however, are abundant.

Among Picarian Birds (*Picariæ*) the brilliantly coloured large-billed Toucans (*Rhamphastidæ*) constitute a family peculiar to the region. A well-known and remarkable family common to South and North America is that of the Humming-Birds (*Trochilidæ*), which for beauty of form and plumage have few serious rivals. Though they range as far north as Alaska, their head-quarters are in the Neotropical region, which is the home of some 400 species, about four-fifths of the total number.

Of Parrots (*Psittaci*) there are a number of genera not represented elsewhere, and the gorgeous long-tailed Macaws (*Conuridæ*) make up a family widely distributed through the region, though also ranging into the Nearctic area.

Among true Game-Birds (*Gallinæ*) the large and handsome Curassows and their allies, which are related to the Mound-Builders of the Australian region, constitute a family (*Cracidæ*) which is almost entirely neotropical. The remarkable Hoatzin (*Opisthocomus cristatus*), native to the northern part of South America (see vol. iii, p. 472), may perhaps be regarded as an aberrant game-bird, but it possesses so many structural peculiarities that it is placed in a distinct family (*Opisthocomidæ*), while some authorities even consider that it is entitled to an order (*Opisthocomi*) of its own.

The South American forms known as Tinamous, sufficiently like game-birds to have earned the local name of "partridges", are in reality very primitive forms, which constitute a distinct order (*Crypturi*). One of the South American Birds of Prey (*Accipitres*), the huge Condor (*Sarcorhampus gryphus*) of the Andes, a kind of Vulture, is the largest existing flying bird, its spread of wing being as much as 9 feet.

The only Running Birds (*Ratitæ*) native to the New World are the Rheas (*Rhea*) or South American Ostriches, which are smaller and less specialized than their African cousins.

Neotropical Reptiles (*Reptilia*).—The warmer parts of the region are inhabited by Crocodiles (*Crocodilus*), and forms known as Caimans (*Caiman*), which are pretty closely related to the Alligators. Among the many Lizards (*Lacertilia*) members of the Iguana Family (*Iguanidæ*) are conspicuous, though the group is shared with North America, and there are outlying forms in Madagascar and the Fiji Islands. The type-genus (*Iguana*) is only represented in tropical America and the West Indies, while the curious Basilisks (*Basiliscus*) are limited to the former area. The Sea-Lizard (*Amblyrhynchus cristatus*) of the Galapagos Islands is remarkable from its habit of browsing on sea-weeds which grow on the sea-floor in shallow water.

Snakes (*Ophidia*) are well represented in the Neotropical region. They include most of the species of Boa, and the gigantic Anaconda (*Eunectes murinus*), which is the largest known serpent. The harmless Coral-Snake (*Ilysia scytale*), coral-red with black rings, is native to tropical South America. Of this species Gadow remarks (in *The Cambridge Natural History*) that, "On account of its beauty, perfectly harmless nature, and for 'cooling purposes', this snake which grows to nearly a yard in length, is sometimes worn as a necklace by native ladies". The name Coral Snake is also applied to a virulently poisonous species (*Elaps corallinus*) native to the same area and also to the Lesser Antilles. It is related to the Cobras and Kraits of India, and the Death-Adders of Australia.

Amphibians (*Amphibia*).—Though tailed forms (*Urodela*) just get into the northern part of the region, the vast majority of its Amphibians are Frogs and Toads (*Anura*). The tongueless and toothless Surinam Toad (*Pipa Americana*), native to the north of South America, is one of the most interesting species,

which has been spoken about elsewhere, as also have some other neotropical forms (see vol. iii, p. 437).

Neotropical Freshwater Fishes (*Pisces*).—A large eel-shaped Lung-Fish (*Lepidosiren*) is peculiar to South America, and the order (*Dipnoi*) to which it belongs is only elsewhere represented in Africa and Queensland (see p. 411).

In ordinary Bony Fishes (*Teleostei*) the region is extremely rich, and a few peculiar forms require mention. One family (*Osteoglossidæ*) is remarkable in the fact that its geographical range closely corresponds with that of the Lung-Fishes, except that it also includes Borneo and Sumatra. One of the neotropical species (*Arapaima gigas*), abundant in the great rivers of Brazil and the Guianas, is the largest freshwater representative of the order, for it may grow to a length of over 15 feet, and attain a weight of more than 400 lbs. Some of the neotropical members of the widely distributed Cat-Fish Family (*Siluridæ*) are small forms distinguished by their armoured skins. The Electric Eels (*Gymnotidæ*) are characteristic of tropical America.

Most Sharks and Rays (*Elasmobranchii*) are typically marine, yet some of the Sting-Rays (*Trygonidæ*) are at home in the great rivers of South America, though the Indian Ocean is the headquarters of the family.

Neotropical Land-Molluscs (*Mollusca*).—The Neotropical region is particularly rich in members of this group, the West Indies being especially so, but it is unnecessary to enter into details. One curious negative feature is the complete absence of all members of the family (*Limacidæ*) that includes the ordinary Land-Slugs of the Old World, these being replaced by other types.

Neotropical Insects (*Insecta*).—Regarding these Wallace makes the following remarks (in *The Geographical Distribution of Animals*):—"The Neotropical region is so excessively rich in insect life, it so abounds in peculiar groups, in forms of exquisite beauty, and in an endless profusion of species, that no adequate idea of this branch of its fauna can be conveyed by the mere enumeration of peculiar and characteristic groups. . . . The Butterflies of South America surpass those of all other regions in numbers, variety, and beauty; and we find here, not only more peculiar genera and families than elsewhere, but, what is more remarkable, a fuller representation of the whole series of families."

It is very interesting to note that in the tropical forests of South America the carnivorous beetles, which in countries like our own live upon the ground, have taken to an arboreal life. They are, in fact, driven from their natural domain by predaceous Ants, the habits of some of which have elsewhere been mentioned (see vol. ii, p. 104).

CHAPTER LXXVI

LIFE IN DIFFERENT SURROUNDINGS—SHALLOW WATER, DEEP WATER, AND SURFACE FAUNAS OF THE SEA

In writing this book an attempt has been made to illustrate some of the innumerable ways in which animals have become adapted to exist in various surroundings or environments. Occasion has been taken to consider pretty fully adaptations to various kinds of food, to the exigencies of life in water, on the ground, in the ground, among the trees, and in the air. It may therefore perhaps suffice here to deal with a few facts having reference to the adaptations which have been evolved in relation to existence in the sea, especially as the last chapter has been mainly devoted to land animals.

In dealing with marine forms it is found convenient to divide the oceans into three zones which pass into one another, the Neritic, the Abysmal, and the Pelagic, each of which is characterized, broadly speaking, by a special fauna. The Pelagic zone includes the surface waters so far as penetrated by light to any marked extent; the Neritic zone extends from high-tide mark to a depth of 500 fathoms; and the Abysmal zone stretches from this into the deepest and gloomiest ocean abysses.

It is further the practice to divide marine animals into the three groups of Benthos, Nekton, and Plankton, according to their locomotor possibilities. In the Benthos are included fixed forms, and animals which creep upon the sea-floor, or burrow in stone, sand, or mud. Adult corals, for instance, possess no power of moving from place to place, most crabs and sea-snails live on the sea-floor, while many annelids and most bivalves burrow. The Nekton is made up of animals, *e.g.* cetaceans and fishes, which are powerful swimmers and easily range from place to place of their own free-will. The Plankton fauna consist of weaker creatures, and numerous larvæ, which float or

drift with the currents, against which the swimming powers that many of them possess can make no headway, though useful in a minor degree. Such are various animalcules, small crustaceans, jelly-fishes, and salps. Floating eggs and innumerable larvæ also belong to the Plankton.

THE NERITIC ZONE—LIFE IN SHALLOW WATER

The Neritic Zone embraces the area between tide-marks, *i.e.* the littoral sub-zone and the shallow waters adjacent. There being abundant light a great variety of colours and patterns are exhibited by the animals, many of these being useful to their possessors in one way or another. And, as might be anticipated, neritic animals mostly possess well-developed eyes, unless they happen to have become adapted to a burrowing mode of life. The fauna of this zone is rich in the extreme, its character varying with climate and the nature of the sea-floor, among other determining circumstances. The intertidal area is of particular interest, for, being exposed to the action of the air at periodic intervals, it is intermediate in character between sea and land, presenting an environment which has rendered possible the evolution of certain terrestrial forms (see vol. ii, p. 459), some of which have again more or less reverted to the ancient aquatic existence. Land-Crabs, for instance, have sprung from purely marine forms, while Cetaceans have undergone a secondary adaptation to the original mode of life that characterized their exceedingly remote fish-like ancestors.

Neritic Mammals (*Mammalia*).—A number of forms which partly belong to the land have more or less claim to be included in the fauna of this zone, though some of them also spend more or less of their time in the Pelagic area. Such in particular are the Sea-Lions or Eared Seals (*Otaridæ*), Walruses (*Trichechidæ*), and Seals (*Phocidæ*), which make up a special group (*Pinnipedia*) of the Flesh-Eaters. The Sea-Cows (*Sirenia*), including the Dugong (*Halicore*) and Manatee (*Manatus*), have deserted the land entirely, though the latter pass up into rivers and are therefore, in part, members of the freshwater fauna.

Neritic Birds (*Aves*).—The nature of the development of birds prevents them from deserting the land altogether, but many species spend so large a part of their lives on the shore or in

shallow water that some allusion to them is necessary here. Among forms which still make considerable use of the land, other than for nesting purposes, the Gulls (*Laridæ*) may be particularly mentioned, and many others have been dealt with in earlier sections, while the Penguins (*Impennes*) are as neritic as it is possible for members of the class to be.

Neritic Reptiles.—The only case requiring mention is that presented by the Sea-Lizard (*Amblyrhynchus cristatus*), which spends a large part of its time feeding on the sea-weeds that grow in the shallow water.

Neritic Fishes (*Pisces*).—These are immensely numerous, and many of them have been dealt with in other sections. The majority of food-fishes, for instance, are neritic, though those of the herring and mackerel kind furnish important exceptions, yet many of these pelagic species favour the zone of shallow water for spawning purposes. The beautiful forms which abound in the neighbourhood of coral-reefs would alone require considerable space to do them justice. The effect produced upon the imagination by the coral-fauna is vividly summarized by Alcock (in *A Naturalist in Indian Seas*) in the following impressionist sentences:—"Looking back after thirteen years, I can only remember visions of fairy groves and glades, lit by a strange ethereal light, half moon half sun, where, among Christmas-trees of purple and blue and golden green, fishes painted like butterflies flitted and hovered". Those who desire to get some notion of the colour-schemes presented by such a fauna are referred to the magnificent plates in Saville Kent's *Great Barrier Reef of Australia*. There are naturally a large number of interesting adaptations to be found among reef-animals, one of which has elsewhere been described (see p. 171). An interesting protective arrangement is found in a Coral-Fish (*Epinephelus hexagonatus*, fig. 1292) common in the Andaman Islands. The dark polygonal patches on its skin harmonize very well with the particular corals among which it feeds. A modification of different kind is presented by the Parrot-Fishes (*Scarus*), which owe their name to the strong curved jaws that enable them to browse upon the branches of various sorts of coral.

Many British fishes of no economic value haunt the neighbourhood of the coast, or may be seen in tidal pools. Such are some of the Gobies (*Gobiidæ*), which include the beautiful Dragonets

(*Callionymus*), and, in warmer countries, the little Mud-Skippers (*Periophthalmus* and *Boleophthalmus*), the habits of which have already been noticed. Other families are those which include the Blennies (*Blenniidæ*), many of the Bull-Heads (*Cottidæ*), and the gorgeously tinted Wrasses (*Labridæ*). There are also the curious Pipe-Fishes (*Syngnathidæ*), remarkable for the brood-pouch possessed by the male, and among these are the Sea-Horses (*Hippocampus*, *Phyllopteryx*, &c.), which are not found in British seas.

Primitive Vertebrates (*Protochordata*) *of the Neritic Zone.*—Lancelets (*Amphioxus*) and Acorn-headed Worms (*Balanoglossus*)

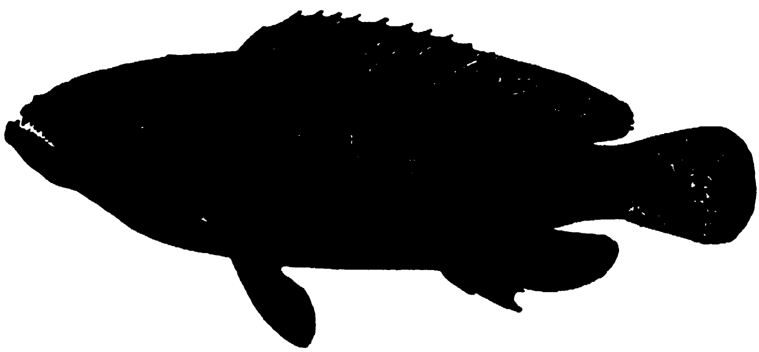


Fig. 1292.—Coral-Fish (*Epinephelus hexagonatus*)

are widely distributed neritic forms, with burrowing habits. The zone is also inhabited by large numbers of Ascidians or Sea-Squirts (*Urochorda*), some solitary and some colonial, which in their adult stage are attached to various objects.

Neritic Molluscs (*Mollusca*).—Head-footed Molluscs (*Cephalopoda*) abound in shallow water, Squids and Cuttle-Fishes, for instance, being found in large numbers around our own coasts, while eight-armed forms, such as the Poulpe (*Octopus*) and its allies, belong as much to the Benthos as to the Nekton, of the Neritic region, for they crawl as much as they swim, or possibly more so.

Sea-Snails and Sea-Slugs (*Gastropoda*) simply swarm both in shallow water and between tide-marks, especially in the tropics. Among the commonest littoral forms on the British coasts are the Limpets (*Patella*), which adhere so closely to the rocks that they defy the wash of the tide, to which their conical shell affords but little purchase; the Purple-Shells (*Purpura lapillus*), well

protected against the buffets of the waves when withdrawn into their thick white dwellings; and the Periwinkles (*Littorina*), including the edible species (*L. littorea*); a smaller, more rounded kind (*L. obtusata*), often of bright-orange hue, which crawls over brown sea-weeds; and a third sort (*L. rudis*), that dwells near high-water mark and has its breathing organs modified in consequence (see vol. ii, p. 459). Sea-Lemons (*Doris*) and other marine slugs are also common.

Among neritic Bivalves (*Lamellibranchia*) forms of economic importance may be mentioned, such as the Oysters (*Ostrea*), attached by the substance of one valve; the Edible Mussels (*Mytilus*), moored by silky byssus threads; the Scallops (*Pecten*), some of which can swim by opening and closing their shells; and the Cockles (*Cardium*), which burrow in the sand. Other delvers in sand or mud are the Gapers (*Mya*), the Razor-Shells (*Solen*), and many more; while Piddocks (*Pholas*) and Date-Shells (*Lithodomus*) are able to excavate dwellings in stone.

Of Primitive Molluscs (*Amphineura*) the flattened Mail-Shells (*Chiton*) live under stones or in rock-crevices.

Neritic Crustaceans (*Crustacea*).—Prominent among these are the Prawns, Shrimps, Lobsters, and Crabs, of many species. Some forms of the last kind which we commonly see on our own coasts are the Edible Crab (*Cancer pagurus*), the green Shore-Crab (*Carcinus mænas*), and, near low-tide mark, the little flattened Porcelain Crabs (*Porcellana*).

Neritic Annelids (*Annelida*).—Of these there is a vast host. Of British forms may be mentioned the actively-creeping Sea-Centipedes (*Nereis*) and many related species; the Sea-Mice (*Aphrodite*), short plump worms with beautiful iridescent bristles; Scale-Worms (*Polynoe*); Lug-Worms (*Arenicola*), that burrow in sand or mud; Sand-Worms (*Sabellaria*), living in communities and gluing grains of sand into dwellings; and various species sheltered in white calcareous tubes, sometimes irregular in shape (*Serpula*), or coiled into small flat spirals (*Spirorbis*) attached to brown sea-weeds.

Other Worm-like Animals of the Neritic Zone.—Here may be mentioned, in passing, the colonial Moss-Polypes (*Polyzoa*), of which the branching skeletons are often taken for sea-weeds; Nemertine Worms (*Nemertea*), slimy unsegmented creatures often found coiled up under stones; Siphon-Worms (*Sipunculus*), that

burrow in the sand; and Turbellarian Worms (*Turbellaria*), variously shaped flattened forms often seen adhering to stones or other objects.

Neritic Hedgehog-Skinned Animals (*Echinodermata*).—In warmer seas, and to some extent in our own, Feather-Stars (*Comatula*) climb or swim in shallow water. Ordinary Star-Fishes (*Asteroidea*) use their numerous tube-feet for creeping, and Brittle-Stars (*Ophiuroidea*) progress on the sea-floor by

Fig. 1293.—Section through part of a Coral Reef

means of their snake-like arms. Sea-Urchins (*Echinoidea*) creep slowly about after the fashion of star-fishes, and their tube-feet adhere so strongly to rock-surfaces that some of them can even withstand the surf of coral-reefs. The Sea-Cucumbers (*Holothuroidea*) of shallow water either creep or burrow.

Neritic Zoophytes (*Cœlenterata*).—On British coasts the solitary Sea-Anemones, often beautifully coloured, are the most noticeable of the Sea-Flowers (*Anthozoa*). The fauna of the Great Barrier Reef of Australia includes some creatures of this kind which are as much as 2 feet in diameter when fully expanded. In some of the warmer seas, where the water is sufficiently clear,

reefs are built up from the dead skeletons of a bewildering variety of Corals, simple or colonial, and the animals to which they belong are closely related to the sea-anemones. Some Corals live on the floor of the deep sea, but the reef-builders, so far as we know, cannot exist in water deeper than about 40 fathoms. Since some reefs extend downwards into much greater depths (their foundations consisting of the skeletons of dead polypes, fig. 1293), Darwin came to the conclusion that such reefs had formed in areas where sea-floor was sinking, but at so slow a rate that upward growth kept pace with it. The theory affords a simple explanation of the ring-shaped reefs known as atolls, which might be supposed to have come into existence from the gradual sinking of islands fringed by reefs (figs. 1294, 1295). Borings recently made on coral islands lend strong support to the hypothesis.

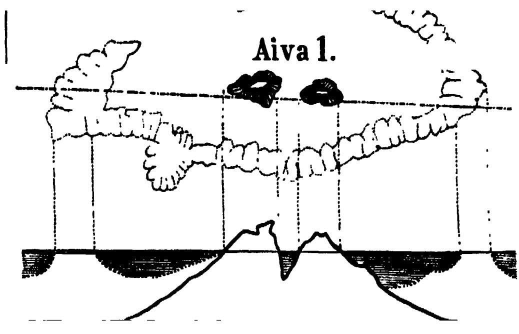


Fig. 1294.—An encircling Coral-Reef in Plan and Section. By gradual sinking of the island, with corresponding upgrowth of coral, an atoll (fig. 1295) might be formed.

Fig. 1295.—An Atoll

The population of the Neritic zone further includes large numbers of hydroid zoophytes and jelly-fishes (*Hydrozoa*), these being in some cases the fixed and free-swimming stages in the life-history of the same species.

THE ABYSMAL ZONE—LIFE IN DEEP WATER

The Abysmal Zone includes that part of the sea into which daylight penetrates but little, if at all. Even the average depth of the ocean, taken as a whole, is about 2100 fathoms (12,600 feet), while the profoundest abysses may be more than double this. The deepest patch at present known is off the coast of New Zealand, where a sounding of over 5000 fathoms (30,000 feet) has been obtained. It was long supposed that the deep sea was entirely devoid of life, but the numerous scientific investigations made during the last few decades have proved that even at great depths there is a rich and varied fauna, closely allied to that of the Neritic zone, but presenting many peculiar features in relation to the entirely different physical conditions. Except where this realm adjoins the Pelagic zone above it, it is probably in complete darkness so far as daylight is concerned, though it is more or less lit up by the phosphorescent glow given out by many of its inhabitants. The pressure is enormous, and the deep sea is also very cold, the temperature of its floor not being far removed from freezing-point. There is a complete absence of plants (except perhaps bacteria), and many of the animals are consequently predaceous in a marked degree. The requisite supply of food is maintained by the dead organisms which rain down from the Pelagic zone, or get washed in at the sides from the Neritic zone. Deep-sea animals present a great variety of colours, though no one tint can be said to characterize the fauna as a whole, and there is generally no blending of different hues in the same animal, nor any complex patterns or markings. It would seem that the utilitarian explanations that are more or less applicable to the colour-schemes of neritic forms fall short here. Certain other features will best be explained by briefly reviewing some of the chief groups of animals.

Deep-Sea Fishes (*Pisces*).—Most of the fishes of the deep sea are black or brown in colour, but some of them are purple, pink, or red, and since these brighter hues are most prevalent in the upper regions of the abyss, at depths of from 100 to 250 fathoms, it is not impossible that they may correspond to a dull kind of sunset illumination due to light which has filtered down from the surface. Many deep-sea fishes are also characterized by the possession of variously arranged phosphorescent organs on

the head and body, but the use of these can only be conjectured in most cases. In some of the Deep-Sea Anglers (e.g. *Melanocetus Murrayi*) a luminous knob at the end of the "lure" almost certainly serves the purpose of attracting prey (see vol. ii, p. 85). The bodies of these abysmal forms are of great fragility, and there is a deficiency of lime in their skeletons. Huge mouths, provided with formidable teeth, associated with swallowing powers of no mean order, distinguish many species, giving them a hungry

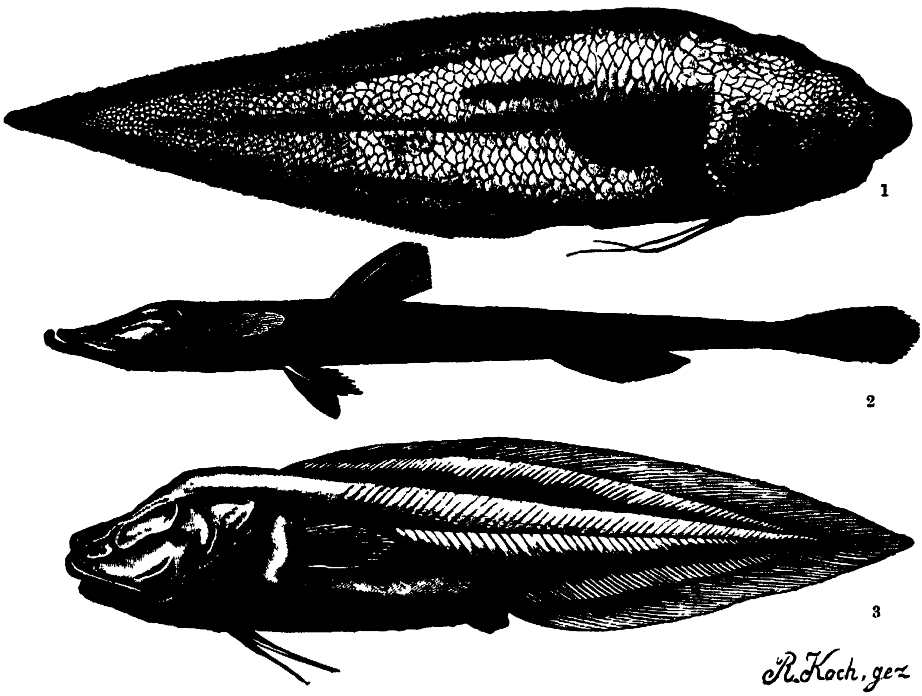


Fig. 1296.—Blind Deep-Sea Fishes. 1, Typhlonus nasus; 2, Ipnops Murrayi; 3, Aphyonus gelatinosus.

and ferocious appearance, and suggesting that no chance of a square meal is let slip. In the manner of sight there are startling differences which at first appear difficult to reconcile. In most cases the eyes are either large and owl-like, serving to catch the faintest rays of light, or else they are degenerate, sometimes, indeed, having entirely disappeared (fig. 1296). It is usually supposed that those fishes descended from ancestors which exchanged neritic for abysmal life with sufficiently plastic eyes, so to speak, to render their adaptation to the new conditions possible, have gradually acquired exaggerated positive characteristics, while the blind or purblind forms have taken origin from ancestors in

which such plasticity was absent. It is also clear that species which spend more or less of their time in the uppermost part of the abyss (and even in the Pelagic zone) have a better chance of improving their organs of vision. But the matter is still in the conjectural stage.

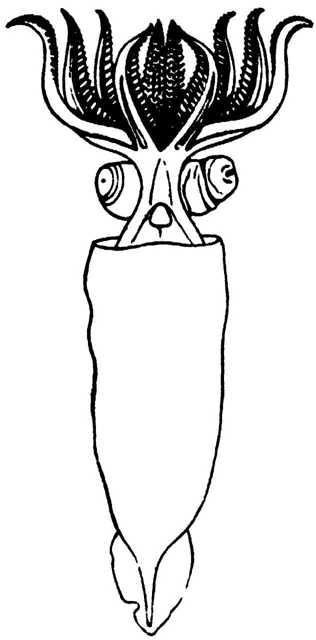


Fig. 1297.—Deep-Sea Cuttle-Fish (*Taonius abyssicola*) with large eyes

Some of the fishes which see indifferently or not at all partly make up for the deficiency by the possession of long feelers, derived from fin-rays, which serve as a means of exploring the surrounding area to some distance (see p. 28).

Deep-Sea Molluscs (*Mollusca*).—Some of the deep-sea Cuttle-Fishes (e.g. *Taonius abyssicola*, fig. 1297) are distinguished by the possession of exceptionally large eyes. The species figured has been dredged from depths of 902–1370 fathoms in the Indian Ocean. There are also several curious Octopods (see vol. iii, p. 33). The Snails and Bivalves possess unusually thin and fragile shells, while some of the former have lost the characteristic rasping-organ (*odontophore*).

Fig. 1298.—Deep-Sea Prawn (*Glyphocrangon priononota*) with large eyes, and well-developed organs of smell

Deep-Sea Crustaceans (*Crustacea*).—Pink and red are here the prevailing colours, but some forms are purple, yellow, cream-

colour, red, and even white, while others are spotted or striped in a simple manner. The hard investment of the body is comparatively thin and free from lime. As among Fishes, we find that the eyes are either greatly developed, or else more or less degenerate. We may take as an example of the former condition a kind of Prawn (*Glyphocrangon priononota*, fig. 1298) inhabiting the Indian Ocean at depths of 865–1022 fathoms. The figure illustrates two other interesting features. One branch of the first feelers (the thicker of the two filaments seen projecting in front) is of large size, and as this is the region which bears the olfactory organs the possession of a keen sense of smell may be inferred. There is, further, a sharp defensive spine at the end of the tail, which can be turned up and held in that position by a sort of "locking joint", acting as a bayonet to repel enemies at close quarters. It also appears that in some deep-sea crustaceans the fluid excreted from the renal organs gives out a phosphorescent light. In another kind

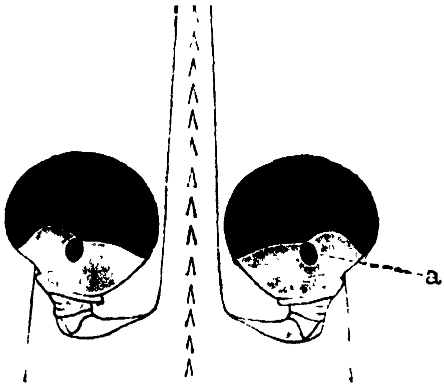


Fig. 1299.—Large Eyes of a Deep-Sea Prawn (*Parapandalus spinipes*), enlarged *a*, Accessory eye (?) or luminous organ (?)

Fig 1300.—A Blind Deep-Sea Shrimp (*Prionocrangon ommatosteres*)

of Prawn (*Parapandalus spinipes*, fig. 1299) there is what looks like a small accessory eye near the big one. If, however, this is really a luminous organ, as some think, the prawn provides its own eyes with light.

To illustrate blind crustaceans we may take one of the Shrimps (*Prionocrangon ommatosteres*, fig. 1300), which is absolutely destitute of eyes.

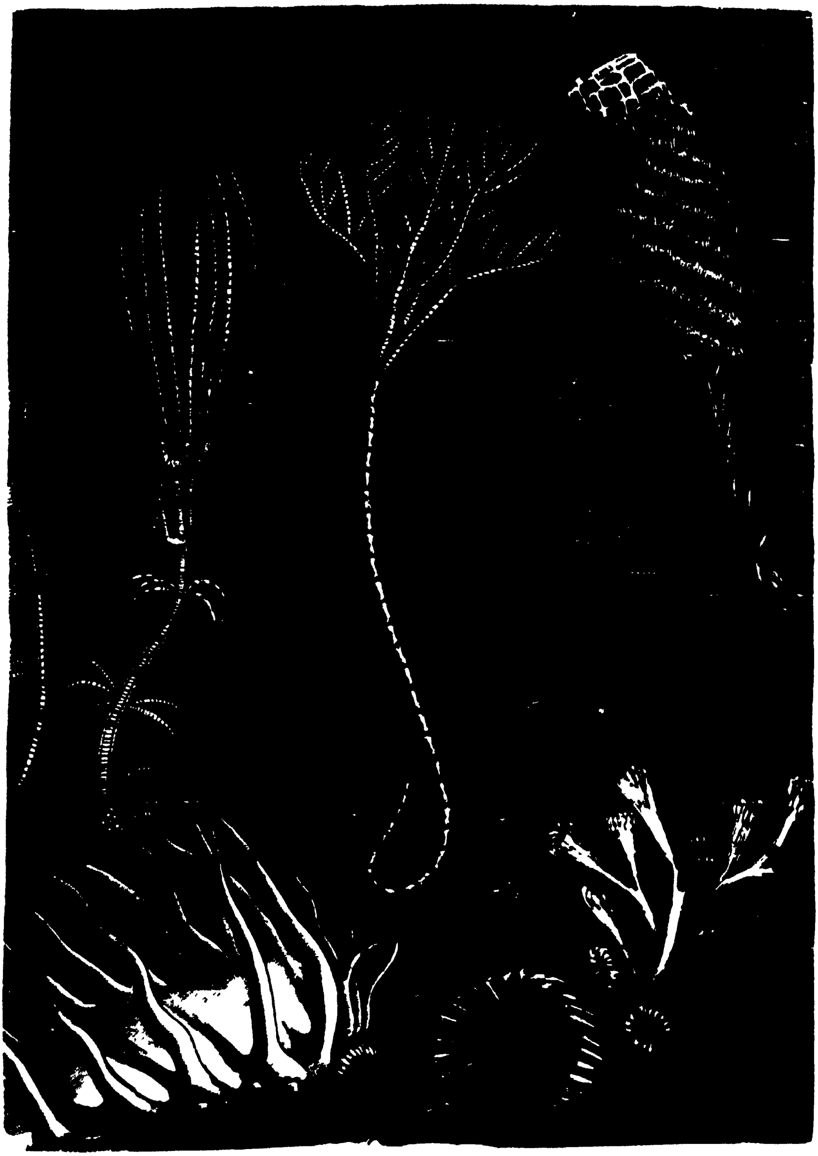


Fig. 1301.—Group of Deep-Sea Animals. In foreground—a Sea-Cucumber on left, and a Coral (*Lophohelia*) on right. At back—Venus' Flower-Basket (*Euplectella*) on right, two Sea-Lilies (*Rhizocrinus* and *Pentacrinus*) in centre, and on left. In the middle—a Pelican Fish (*Saccopharynx pelecanoides*).

The Stopper-Fisted Hermit-Crabs (*Pylocheles*) of the Indian Ocean and Caribbean Sea do not possess the twisted tails of our common native species, which live in cast-off snail-shells, nor is one of the pincers much larger than the other. These particular hermits are in all respects symmetrical, in adaptation

to their dwellings, which consist of water-logged joints of mangrove or bamboo. The large pincers act as a front-door, but a loophole is left between them to serve as a means of observation.

Certain kinds of crustacean grow to a very much larger size in the deep sea than elsewhere. Among the Slaters (*Isopoda*), for example, of which the terrestrial wood-lice are the most familar types, we find one species (*Bathynomus giganteus*) which is a foot long.

Hedgehog-Skinned Animals (*Echinodermata*) *of the Deep Sea.*—Star-Fishes, Brittle-Stars, and Sea-Urchins are all abun-

Fig. 1302.—Deep-Sea Pycnogonid (*Colossendeis*)

dantly represented in the abyss, while the beautiful Sea-Lilies (*Crinoidea*, fig. 1301), the representatives of a once dominant group, are found only in this zone. To this too are restricted the Elasipods, remarkable and apparently primitive types of the Sea-Cucumbers (*Holothuroidea*). They have a flattened under surface, and creep about like slugs on the soft deposits which cover the sea-floor (fig. 1301).

Abysmal Sea-"Spiders" (*Pycnogonida*). — These curious jointed-limbed animals, which in the Neritic zone are represented by comparatively small forms, attain relatively colossal proportions in the abyss. One of them (*Colossendeis*) is represented in fig. 1302.

Deep-Sea Corals (*Anthozoa*) *and Sponges* (*Porifera*).—Some

very beautiful Corals and Sponges are found in the deep sea. Some of the latter resemble elegant vases in shape, with walls supported by glassy threads interwoven like lace (fig. 1301). Others are moored in the soft deposits of the sea-floor by long bundles of slender spicules of similar nature.

PELAGIC ZONE—SURFACE LIFE

It will here be convenient to consider separately animals which are powerful swimmers (Nekton) and those which float or drift (Plankton).

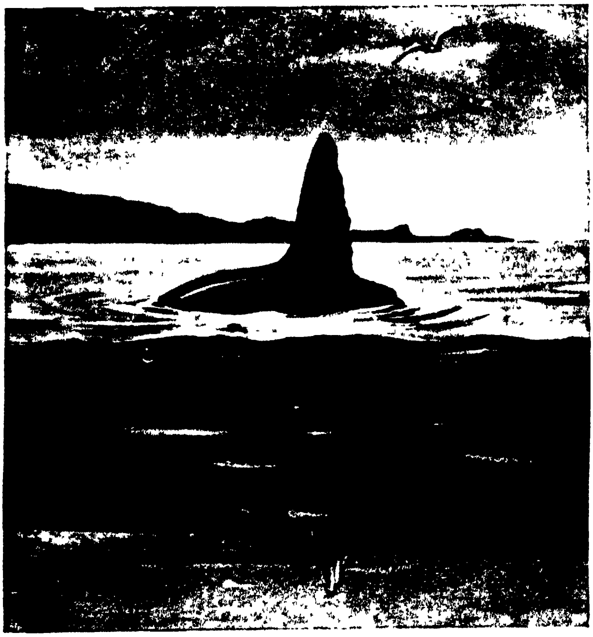


Fig. 1303 —Sun-Fish (*Orthagoriscus mola*)

PELAGIC NEKTON.—Among Mammals we find that the Pinnipede Carnivores (see p. 436) spend more or less of their time in this zone, to which they partly belong. More purely pelagic, and altogether independent of the land, are Whales and their allies (*Cetacea*). There are also Birds which are pelagic, notably the Albatross (*Diomedea exulans*) and the Tropic Birds (*Phaëthon*); while the Sea-Snakes (*Hydrophinæ*) of the Indian Ocean and part of the Pacific belong here in the main. A number of Fishes are chiefly met with in the open sea, among them being the Blue Shark (*Carcharias glaucus*) and the Rondeletian Shark (*Carcharodon Rondeletii*). The Flying-Fish (*Exocœtus volitans*) and its enemy the Bonito (*Albicore bonito*) are also pelagic, and so is the remarkably-shaped Sun-Fish (*Orthagoriscus mola*, fig. 1303). Many of the best swimmers among the Cuttle-Fishes and Squids are also found at or near the surface of the sea, far away from land.

PELAGIC PLANKTON.—The floating and drifting population of the sea possess a number of common characteristics related to their mode of life. They are typically translucent or transparent, a feature due to the large proportion of water in their tissues. By making some of them more or less difficult to see, this may serve to some extent as a means of protection (see vol. ii, p. 278), and by reducing the density of their bodies it must certainly

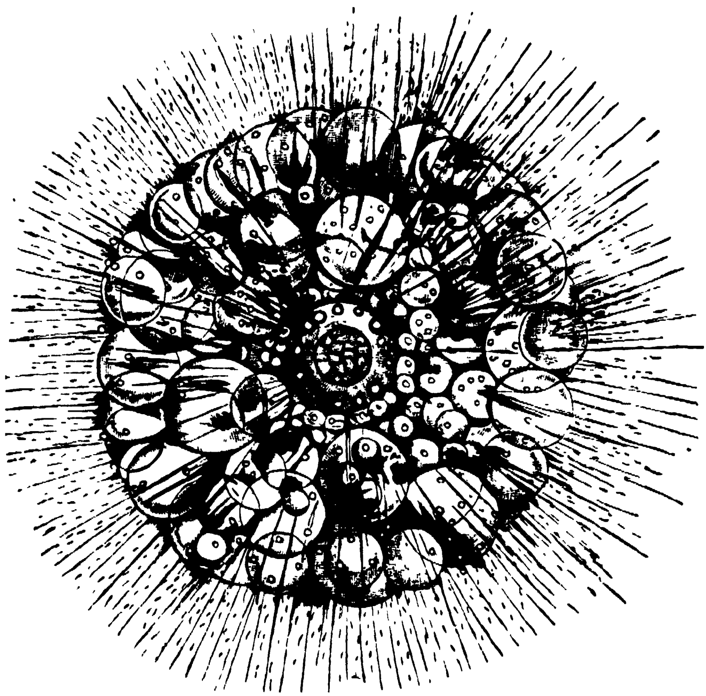


Fig. 1304.—A Ray-Animalcule (*Thalassicola pelagica*) with "bubbly" protoplasm, much enlarged.

render floating a comparatively easy matter. The latter purpose is also promoted by arrangements of other kind. In many of the minute crustaceans and crustacean larvæ, for example, there are numerous spines and hairs which must reduce the tendency to sink. Oil-globules are of common occurrence, both in adult animals and in some floating eggs, such as those of fishes. And there may also be gas-receptacles for buoying up the body. In some of the Animalcules, for example, the living substance (protoplasm) of the animal is of "bubbly" consistency, owing to the presence of minute spaces filled with liquid, or even gas (fig. 1304). In many of the Compound Jelly-Fishes (*Siphonophora*) there is a gas-filled float at the upper end of the colony,

and sometimes (*Velella*, fig. 1305) a crest projecting from this may almost be said to serve as a sail.

It must not be supposed, however, that plankton animals are always found at the surface, for, on the contrary, they are able to withdraw themselves from it to a greater or less depth, and thus avoid the damaging effects of a rough sea or an excess of temperature. Our ignorance is at present too great to enable us to explain the reasons for all the upward or downward movements which constantly go on, sometimes in a curious periodic manner. As Hickson says (in *The Story of Life in the Seas*,

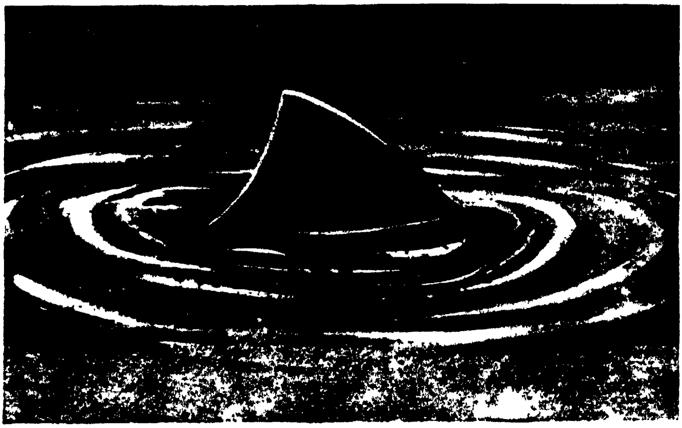


Fig. 1305.—Velella

a little book which is heartily commended to the attention of readers):—"The fact is, that the conditions of life in the surface waters are so complicated that it is extremely difficult for us to accurately estimate the balance of the forces which act upon these organisms. The direct heat of the sun, the light of both the sun and the moon, the tranquillity or roughness of the sea, the conditions of the tides and winds which cause changes in the surface temperature of the water, independently of the direct heat of the sun, all influence the delicate tissues of which these animals' bodies are composed, and cause them to change their position." Phosphorescence is another common property of plankton animals, and its meaning is in many cases difficult to understand. Planktons are of very various character. Some contain animals of many different species, others consist of a single form of life.

Vertebrates (*Vertebrata*) *of the Plankton.*—Among Fishes (*Pisces*) occasion has already been taken to note (see vol. iii,

p. 425) that a great many species lay floating eggs, and these, together with the transparent larvæ that hatch out of them, belong to the plankton fauna. Primitive Vertebrates (*Protochordata*) are abundantly represented by certain Sea-Squirts or Ascidians (*Urochorda*), including some little tadpole-shaped forms (*Appendicularia*, &c.), Barrel Ascidians (*Doliolum*), Salps (*Salpa*), and Fire-Cylinders (*Pyrosoma*), all of which have received notice

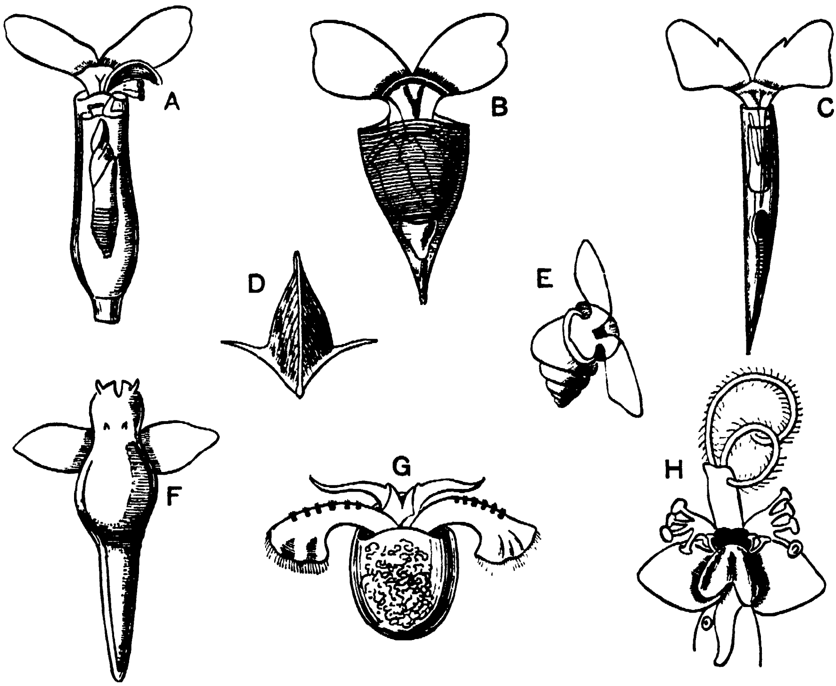


Fig. 1306.—Wing-Footed Snails (*Pteropoda*). A, Cuvierina; B, Clio; C, Creseis; D, shell of Cleodora; E, Limacina; F, Clione; G, Halopsyche; H, front part of Pneumoderma, with hook-bearing tubes and groups of stalked suckers, for securing prey. A–E, Shell-bearing forms; F–H, shell-less forms.

in earlier sections (see vol. i, p. 299; vol. iii, pp. 38 and 422; and p. 106 of present volume).

Plankton Molluscs (*Mollusca*).—The beautiful Violet-Snail (*Ianthina*), with its egg-raft, belongs here, also the members of the remarkable and diversified group of Fin-Footed Snails (*Heteropoda*), and a curious little Sea-Slug (*Phyllirhoë*), which is flattened from side to side (see vol. iii, pp. 34 and 36). Far more characteristic than these, however, are the little Wing-Footed Snails (*Pteropoda*, fig. 1306), which are often found associated in vast shoals, affording an important contribution to the bill of fare of animals so large as Whales.

The larvæ of numerous Molluscs simply swarm in the surface waters of the sea.

Plankton Insects (*Insecta*).—Although Insects are essentially land-forms, a few Bugs (e.g. *Halobates*) live on the surface of the open sea.

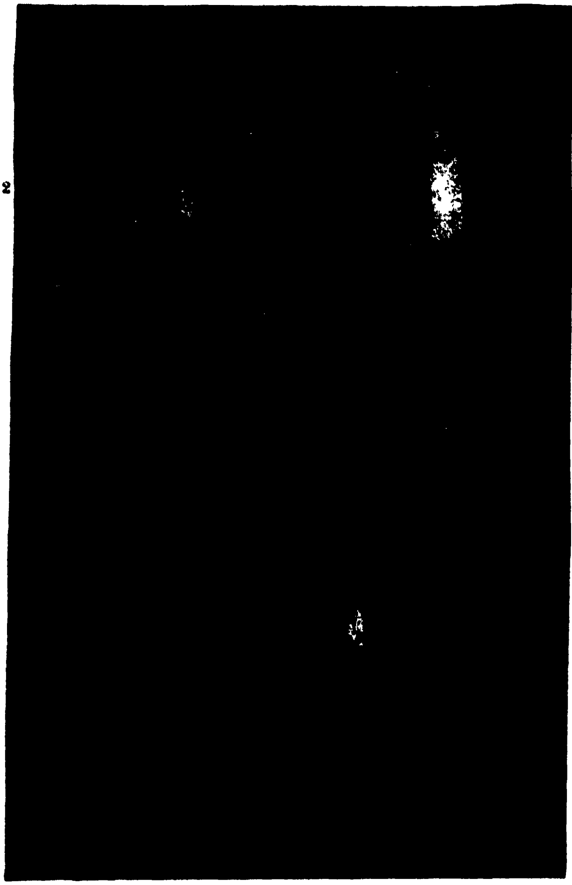


Fig. 1307.—Fork-Footed Crustaceans (*Copepoda* with well-developed limbs. 1, Oncæa venusta. 2, Copilia vitrea. 3, Calocalanus pavo.

Plankton Crustaceans (*Crustacea*).—Many members of this group, and innumerable crustacean larvæ, are among the most important plankton animals. Some, as the Swimming-Crabs, may be of fair size, but by far the most dominant order is that of the Fork-Footed Crustaceans (*Copepoda*, fig. 1307), which are of great economic importance, because they constitute the staple diet of Herrings and some other valuable food-fishes (see p. 283).

Plankton Annelids (*Annelida*).—Some members of this group are specially adapted to a life in the surface waters, and one remarkable example (*Tomopteris*) has elsewhere been described (see vol. iii, p. 22).

Plankton Echinoderms (*Echinodermata*).—The curious larvæ of all sorts of Echinoderms are abundantly found in plankton at certain times of the year, but the adult members of the group seem little suited for this kind of life. A kind of Sea-Cucumber (*Pelagothuria*), however, has acquired the necessary adaptations for the purpose (see vol. iii, p. 24).

Nemertine Worms (*Nemertea*) *of the Plankton.*—The larvæ

of these curious Worms, like those of the last-named group, are well represented in the surface waters of the sea, and some adult Nemertines have given up creeping and taken to a pelagic life. One of the most remarkable (*Pelagonemertes*) is represented in fig. 1308.

Plankton Thread-Worms (*Nemathelmia*). — Among the commonest inhabitants of the surface waters are the curious little fish-shaped Arrow-Worms (*Sagitta*, *Spadella*, &c.), which constitute a special group (*Chætognatha*) that is generally supposed to be an outlying constituency of the Thread-Worms (see vol. iii, p. 21), though its affinities are doubtful.

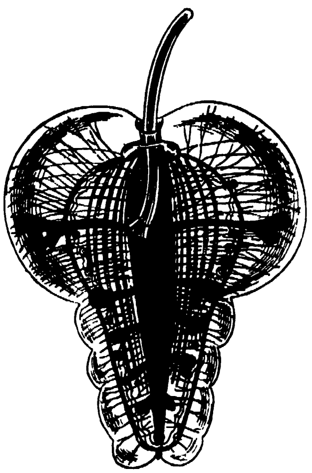


Fig. 1308.—Pelagic Nemertine Worm (*Pelagonemertes*), reduced

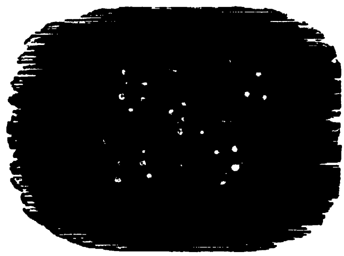


Fig 1309.—Night-Light Animalcules (*Noctiluca*), enlarged

Fig. 1310.—Shells of Ray-Animalcules (*Radiolaria*), imbedded in the fibrous skeleton of a sponge

Plankton Zoophytes (*Cœlenterata*).—A bewildering variety of jelly-fishes, belonging to all sorts of groups, abound in the surface waters. Many of them have abandoned altogether the fixed zoophyte-stage that is found in the life-history of many such creatures (see vol. iii, p. 349). Perhaps the most interesting

among them are the Compound Jelly-Fishes (*Siphonophora*), which are floating colonies, often of very complicated nature, as the members of the colony are modified in many various ways in order to fit them for diverse functions (see p. 103).

Plankton Animalcules (*Protozoa*).—One very interesting form, the Night-Light Animalcule (*Noctiluca*, fig. 1309), is a common cause of the phosphorescent appearance of the sea around our

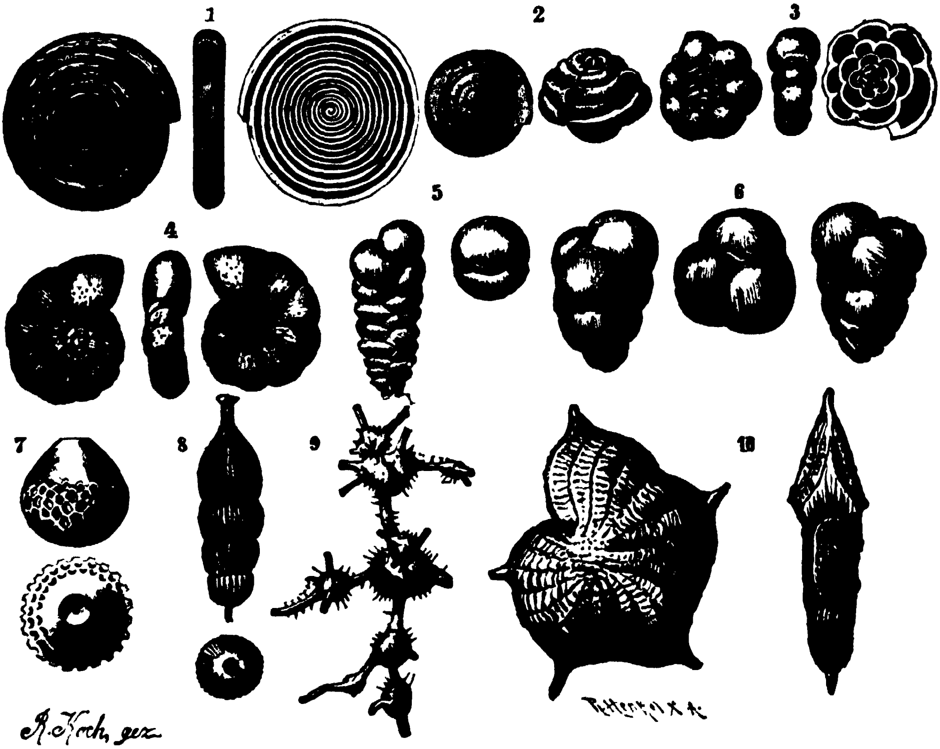


Fig. 1311.—Group of Foraminifera. 1, Ammodiscus incertus; 2, A. charoides; 3, Trochammina coronata; 4, T nitida; 5, Textularia agglutinans, 6, Verneuilina pygmaea; 7, Lagena seminuda; 8, Nodosaria scalaris; 9, Ramulina globulifera, 10, Polystomella imperatrix.

coasts. Two groups are very dominant in the plankton, the Ray-Animalcules (*Radiolaria*, fig. 1310) and the Forams (*Foraminifera*, fig. 1311). The former possess a flinty skeleton, often of great complexity and beauty, while the latter are provided with elegant calcareous shells of the most various shapes. Vast areas of the sea-floor are covered by soft "oozes", which are largely composed of the hard parts of deceased members of these two groups that are being continually rained down from the surface waters. There also appear to be some few species

of both groups that actually live on the floor of the abysmal zone.

Besides the typical plankton fauna which has just been briefly dealt with, the Pelagic zone is also inhabited by another assemblage of animals associated with various drifting objects, and particularly with the vast accumulations of sea-weeds that are found in the Sargasso Sea and elsewhere. Details would here be out of place, but it may be remarked that fixed forms of life, such as hydroid zoophytes, by attaching themselves to floating sea-weed, are enabled to maintain a foothold in the Pelagic zone. It is a matter of common knowledge that one of the most curious of fixed Crustaceans, the Ship-Barnacle (*Lepas*), is commonly found adhering to drifting objects.

The skins of Whales and Fishes also afford a home to quite a number of attached species, some of which are external parasites belonging to various groups. And many pelagic animals are also the unwilling hosts of numerous internal parasites, from which no zone affords escape.

Large bodies of fresh water may also be divided into zones, inhabited by characteristic faunas. The plankton of lakes is of particular interest, and also of some economic importance, as its population augments the food-supply available for freshwater fishes.

CHAPTER LXXVII

DISTRIBUTION IN TIME—THE GEOLOGICAL RECORD

If a large and complicated tree were submerged in water except the ends of some of its branches, these ends, projecting above the surface, would have the same sort of relationship to one another as existing groups of animals. To sketch the submerged tree on the evidence of the parts seen above water would prove a hopeless task, and to determine the mutual affinities of existing groups of animals without knowledge of their past history is also a difficult matter, though structure and development give many clues. Geology, however, furnishes us with a great deal of material from which to reconstruct the ancient life-history of the earth. It deals with periods of which the oldest date back to immensely remote times, if measured by the ordinary human standards of years and centuries, and the history of mankind occupies only the last page of the chronicle.

THE GEOLOGICAL RECORD.—At the present time deposits of sand, mud, and limestone are being formed in the sea, in bodies of fresh water, and some other places, and these enclose the remains of dead animals, such as are well provided with hard parts standing the best chance of preservation. These deposits are arranged in successive layers, of which the uppermost are necessarily the youngest, and contain the remains of such animals as have most recently deceased. Examination of the hard framework of the land shows that a large part of it is made up of rocks, such as clay, slate, sandstone, and limestone, which are similarly arranged in layers, *i.e.* are *stratified*, each such layer being known as a *stratum* (fig. 1312). Imbedded in these strata are *fossils*, which are no other than the remains of animals (and plants) which once existed, or markings, *e.g.* footprints and other impressions, that prove the existence of certain forms of life at the time when the rocks containing them were formed. These strati-

fied rocks, the pages of the geological record, are the deposits formed in ancient seas and ancient lakes, or more rarely on old land-surfaces, in the same way that sand, or mud, or ooze is now accumulating on the floor of the existing ocean, in existing bodies of fresh water, or, it may be, on land. Such old deposits, however, have usually undergone more or less consolidation, and those which we now find above-water owe their present position to movements of elevation, such as are even yet in progress in certain parts of the world. But as these movements are generally extremely slow, they usually produce no obvious result in the brief span of a human lifetime. Remembering that a particular stratum or layer of rock (and of necessity its fossils) is older than those which rest upon it, and younger than those which underlie it, geologists have been able to arrange the different strata in their proper chronological sequence, and thus to construct a continuous geological record, often picturesquely known as the "record of the rocks". The fossils of the record obviously afford some idea, though necessarily an imperfect one, of the successive faunas of the globe for many millions of years, how many can only be conjectured. A hundred millions is a common estimate, based on many different kinds of evidence.

Fig 1312.—Strata in Vertical Sectio

GEOLOGICAL PERIODS.—Without entering into details which may be found in any text-book of geology, it may be stated that the geological record can be divided into four great epochs, which are, beginning with the youngest:

KAINOZOIC EPOCH (Gk. *kainos*, recent; *zoē*, life).—Age of Birds and Mammals.

MESOZOIC EPOCH (Gk. *mesos*, middle; *zoē*).—Age of Reptiles.

PALÆOZOIC EPOCH (Gk. *palaios*, ancient; *zoē*).—Age of Amphibians, Fishes, and Invertebrates.

EOZOIC EPOCH (Gk. *eos*, dawn; *zoē*).—Age of Unknown Life.

The time represented by these four epochs is of very unequal length, but the Kainozoic, in which we live, has endured for a much shorter period than the Mesozoic, which in its turn was briefer than the Palæozoic, while possibly the Eozoic was longer than the other three put together. The entire geological record includes stratified rocks to a thickness of over 100,000 feet, a

sufficiently bulky volume in which to study the evolutionary history (phylogeny) of animal groups. As will be seen from the above indication of the types dominant in the successive epochs, there has been a successive progress from low to high, in conformity with the doctrine of evolution; but the record is very imperfect, and that part of it belonging to the Eozoic is made up of pages which so far have turned out to be practically blank. Many parts of the world, however, are as yet unexplored, so far as their geology is concerned, and during the last few decades the additions to our knowledge have been so great that much is to be hoped for in the future.

LIFE IN THE PALÆOZOIC EPOCH

That animal life existed long before the commencement of this epoch is sufficiently shown that in its earliest stage all the great groups of Backboneless Animals (Invertebrata), save those entirely devoid of hard parts capable of preservation, are represented, mostly by forms which we are able to classify with some approach to certainty. And before the epoch came to an end all the classes of Backboned Animals (Vertebrata), except Primitive Vertebrates (of the past history of which, owing to the soft nature of their bodies, we can never hope to learn much), Birds, and Mammals, had come into existence, as testified by numerous fossils.

PALÆOZOIC ANIMALCULES (PROTOZOA).—The Ray-Animalcules (*Radiolaria*) and Forams (*Foraminifera*) are here and there abundant. The flinty shells of the former make up hard siliceous bands (cherts) which were certainly deposited in very deep water, and correspond to the Radiolarian oozes which now cover parts of the ocean floor. Some of the limestones (*e.g.* the Fusulina limestone) belonging to that part of the epoch when our coal-fields were formed are made up mainly of the shells of Foraminifera, and these may be compared to the wide-spread foraminiferal oozes of the present day.

It may be remarked, in passing, that some of the rocks of the Eozoic epoch (in Brittany) contain the remains of Ray-Animalcules.

PALÆOZOIC ZOOPHYTES (CŒLENTERATA).—The variously-shaped colonial forms known as Graptolites (*Rhabdophora*, fig. 1313) are largely represented in some of the older Palæozoic rocks, and the

group died out entirely before the end of the epoch. They were very probably related to the existing Hydroid Zoophytes, and most of them belonged to the plankton of their time, and were most likely attached to drifting masses of sea-weed. In fact, Sargasso conditions were probably then more widely spread than now.

Corals were extremely abundant, and some of them were reef-builders, but they were mostly of a more primitive type than those now existing, and chiefly belonged to the extinct group of Four-Rayed Sea-Flowers (*Tetractinia* or *Rugosa*).

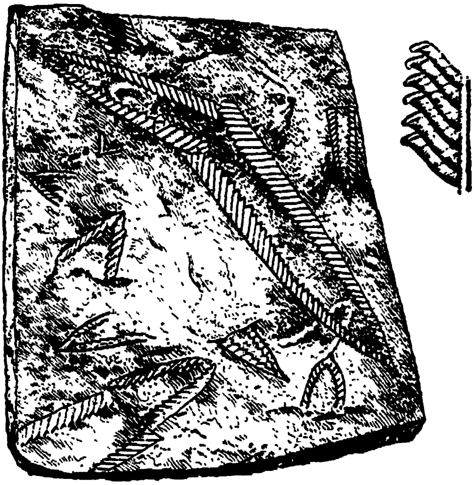


Fig. 1313.—Forked Graptolites (*Didymograptus*) on the surface of a piece of rock. A small part of one is drawn to a larger scale.

Palæozoic Hedgehog-Skinned Animals (Echinodermata).—Sea-Lilies (*Crinoidea*), now a declining group, were extremely abundant, and some of the Palæozoic limestones are mainly composed of their remains. Two other classes of fixed Crinoids are limited to this epoch, and one of them (*Cystoidea*) is of particular interest, because it probably represents the stock from which all other echinoderm groups have been derived, directly or indirectly. The other order (*Blastoidea*) was a sterile side-branch. Star-Fishes (*Asteroidea*) and Brittle-Stars (*Ophiuroidea*) were both represented, and one of the former (*Palæodiscus*) possessed a biting apparatus like that of many Sea-Urchins. The class (*Echinoidea*) to which creatures of the last-named kind belong was represented by a number of primitive types, with more numerous plates than later species, and (on the evidence of Palæodiscus) it has been suggested that Sea-Urchins are descended from Star-Fishes.

Palæozoic Lamp-Shells (Brachiopoda).—This group of greatly specialized worms, distinguished by the possession of a bivalve shell, at the present time contributes but little to the fauna of the sea. In the Palæozoic epoch it was extremely

dominant, and embraced a great variety of species, mostly belonging to extinct types. It is notable, however, that some of the lowlier forms which lived at the beginning of the period, *e.g.* the Tongue-Shells (*Lingula*, &c., fig. 1314), have persisted to the present day with but slight modification, so far as can be judged from the shell alone. That these and other "persistent types" should remain unmodified for vast periods of time has been brought forward as an argument against the doctrine of evolution. It is, on the contrary, what might be expected to sometimes occur in animals devoid of relatively complex adaptations to their surroundings. It was also at one time positively stated that Lamp-Shells, taken as a whole, afford no instance of modification on evolutionary lines. Of late years, however, thanks to the brilliant work of the American school of geologists, we know that the evidence afforded by this group is enough in itself to convince any candid naturalist that evolution has been the guiding principle in the animal world.

Fig 1314 — A fossil Tongue-Shell (*Lingulella*, somewhat enlarged

PALÆOZOIC JOINTED-LIMBED ANIMALS (ARTHROPODA).—All the existing orders of *Crustaceans* (*Crustacea*) were represented

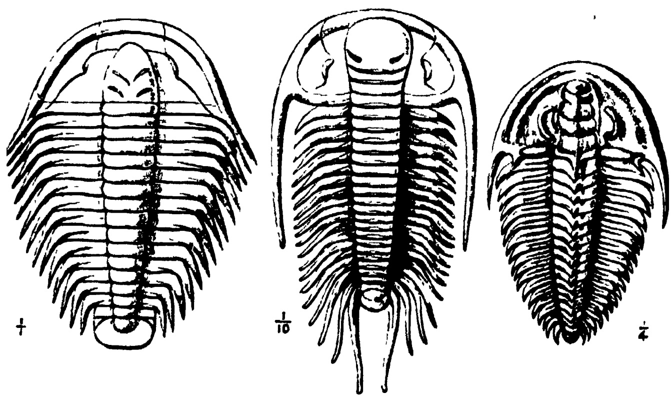


Fig 1315.—Upper Surfaces of three Trilobites. Olenus (left), Paradoxides (centre), Olenellus (right). Actual size indicated by the fractions.

in the fauna of this epoch, except the Fork-footed Crustaceans (*Copepoda*), which are of too delicate a nature to be preserved as fossil, though they no doubt existed. It is noticeable that some of the more primitive types made their appearance very early, the contrary being true for the more specialized ones, such as creatures of the prawn and crab kind.

The curious *Trilobites* (*Trilobita*, fig. 1315), which constituted a closely allied class, were dominant in the older Palæozoic periods, but became entirely extinct before the end of the epoch. In these creatures the upper side of the body was covered by a firm investment divided into a head-shield, a varying number of thoracic segments, and a tail-shield. There was also, as a rule, a longitudinal division into three regions, and this is the origin of the name "trilobite". The numerous species exhibited a great range of characters, both as regards size, shape, and other features. The upper side of the head-shield often bore a pair of eyes, frequently large and facetted, but visual organs were sometimes entirely absent. Our knowledge of the under surface and limbs of trilobites was very incomplete till comparatively recently, partly on account of the delicacy of these parts, but now, chiefly owing to the investigations of American geologists on certain well-preserved species, many points relating to them have been elucidated. The head carried a pair of slender feelers, and there were numerous pairs of forked limbs used for crawling and swimming, while some of those in the region of the mouth acted as jaws (fig. 1316). Many of the stages in growth have been observed, and it may be said that trilobites which, when adult, are of simple structure, resemble the early stages of those which attain to greater complexity. This is precisely what the doctrine of evolution would lead us to expect. It may be added that many trilobites were able to roll up like hedgehogs, and this was no doubt a means of protection.

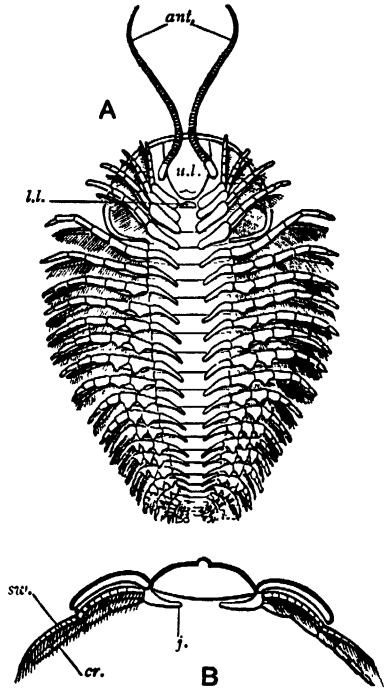


Fig 1316.—A, Under side of a Trilobite (*Triarthrus*) restored, showing the numerous jointed limbs. *ant.*, antennæ, *u.l*, upper lip; *l.l*, lower lip. B, Diagrammatic cross-section through same, showing limb-regions. *j*, Projection serving as a jaw; *sw* and *cr.*, swimming and creeping branches.

Appearing rather later in time than the Trilobites, which they to some extent supplanted, we find *Eurypterids* (e.g. *Pterygotus*, fig. 1317), some of which attained a length of about 5 feet. They died out before the end of the epoch, and appear to have

been related to the Crustaceans. The *King-Crabs* (*Xiphosura*), now represented by a single genus (*Limulus*), first made their appearance in Palæozoic times. They are sometimes included with the Eurypterids in a special group (*Merostomata*).

Centipedes and *Millipedes* (*Myriapoda*) were represented by several palæozoic forms with somewhat primitive characters, while among *Spider-like Animals* (*Arachnida*) there were Scorpions, which appeared comparatively early, Whip-Scorpions, and Spiders, besides representatives (e.g. *Eophrynus*, fig. 1318) of

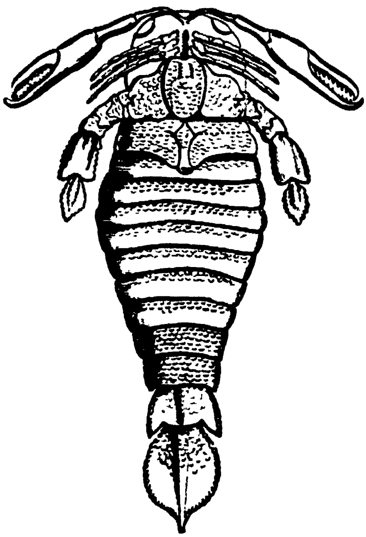


Fig 1317.—A Eurypterid (*Pterygotus*), much reduced

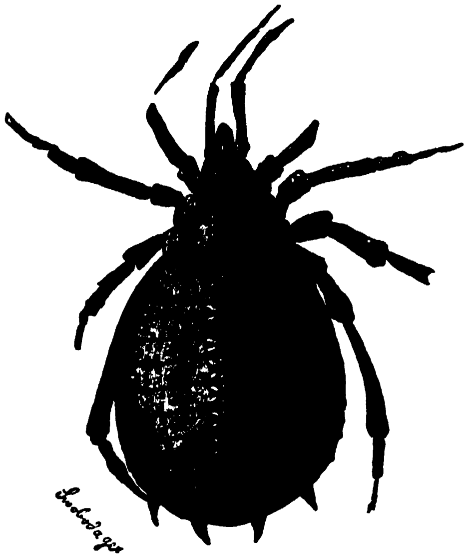


Fig. 1318.—An extinct Arachnid (*Eo*

an order limited to the epoch. Four orders of *Insects* (*Insecta*) had palæozoic representatives, *i.e.* Primitive Wingless Insects (*Aptera*), Straight-Wings (*Orthoptera*), Net-Wings (*Neuroptera*), and Bugs (*Hemiptera*). Some of them were of considerable size, and it is by no means certain that the older types really belonged to existing orders.

PALÆOZOIC MOLLUSCS (MOLLUSCA).—Among *Head-Footed Molluscs* (*Cephalopoda*) now existing, only the Pearly Nautilus (*Nautilus*) possesses an external shell, of which the part not occupied by the animal is divided by partitions into a series of gas-filled chambers. But in the palæozoic rocks we find the remains of a great many species thus characterized. Their shells were straight, curved, open spirals, or closed spirals, like that of Nautilus, which dates back to the middle of the epoch. It seems

probable that the straight-chambered shell was first evolved, and that this gradually underwent a process of coiling up, as a means of facilitating locomotion.

Marine *Snails* (*Gastropoda*) are abundantly represented among the palæozoic fossils, and it may be said generally that they belonged to the more primitive families, and were mostly of vegetarian habit. We also know that Land-Snails existed. The *Tusk-Shells* (*Scaphopoda*) date back to this epoch, and *Bivalves* (*Lamellibranchia*), the older ones of primitive type, were abundant. *Primitive Molluscs* (*Amphineura*) were represented by Mail-Shells (*Chiton*, &c.) of various kind.

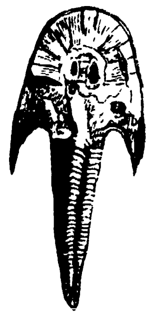


Fig. 1319.—An Ostracoderm (Cephalaspis), much reduced

PALÆOZOIC FISHES (PISCES).—There is no clear proof of the existence of fishes in the earlier rocks of the epoch, but later on they became abundant. The teeth and spines of *Sharks*, &c. (*Elasmobranchii*), are common fossils, and the armour-plated marine ancestors of *Ganoids* (*Ganoidei*) were abundantly represented, as also forms in all probability ancestral to the *Lung-Fishes* (*Dipnoi*). Many palæozoic fishes also belonged to orders that are now extinct. Some of the oldest of the fish-like forms, distinguished by a covering of shelly plates on the front part of the body, also by the absence of lower jaws and paired fins, were probably not really fishes at all, and have been placed in a special group (*Ostracodermata*, fig. 1319) of lower rank.

PALÆOZOIC AMPHIBIANS (AMPHIBIA).—These are represented in the second half of the epoch by numerous species, all belonging to an extinct order (*Stegocephala*), distinguished by the possession of skins which were more or less armour-plated, especially on the head. While some of these creatures were small, others attained considerable dimensions. The footprints of some of them have been preserved. The chief interest attaching to the order lies in the fact that it was probably ancestral to Reptiles. It is also worth while noting that some few members of the order (e.g. *Dolichosoma*) were limbless and snake-like, suggesting a comparison with the recent Cæcilians (*Gymnophiona*), a widely distributed and in some respects primitive group, *e.g.* in the possession of little bony plates in the skin.

PALÆOZOIC REPTILES (REPTILIA).—A few fossil types from

the last stage in the Palæozoic epoch, formerly placed in the Stegocephala, are now referred to an extinct order of Reptiles (*Proreptilia*), which furnishes the nearest approach to the original reptilian stock. A further stage in evolution was represented by a second order (*Rhynchocephala*), from which the remaining groups of reptiles have probably sprung. There is a single existing species, the Tuatara (*Hatteria punctata*) of New Zealand. There were some other palæozoic reptiles, but these will be mentioned in dealing with the succeeding epoch.

LIFE IN THE MESOZOIC EPOCH

The animals of this epoch approached more nearly those of the present day than did their palæozoic predecessors. They included, however, a number of remarkable extinct groups, some of which were extremely dominant, while other classes, *e.g.* Birds and Mammals, which now play leading parts, were but feebly represented.

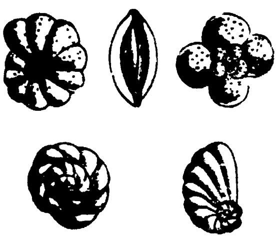


Fig. 1320.—Foraminifera from the Chalk

MESOZOIC ANIMALCULES (PROTOZOA).—The familiar chalk, which makes up the "white cliffs of Albion", and ranges east far into Asia, was deposited in the later part of the epoch. It is very largely made up of the remains of Foraminifera (fig. 1320), and before compacted and upheaved must have borne a close resemblance to the foraminiferal oozes which are now spread over a large part of the ocean floor.

MESOZOIC SPONGES (PORIFERA).—During the chalk period a large number of Sponges possessed of siliceous skeletons existed in the moderately deep sea, and it is their remains which chiefly furnished material for the large flint nodules that abound in part of the chalk, and which have a very particular interest for students of the evolution of human civilization, since from them many of the stone implements and weapons of prehistoric European races were fashioned.

MESOZOIC ZOOPHYTES (CŒLENTERATA).—Corals were extremely abundant during the epoch, and many of them were reef-builders. They belonged to the same great group (*Hexactinia*) that includes the most typical recent forms, being, like them, distinguished by a six-rayed symmetry.

MESOZOIC HEDGEHOG-SKINNED ANIMALS (ECHINODERMATA).—Sea-Lilies (*Crinoidea*) were far less dominant than during the Palæozoic epoch, and were represented by types of different kind, some of them (e.g. *Pentacrinus*) being closely allied to forms now living in the deep sea. Feather-Stars, belonging to the same class, but distinguished by the fact that when adult they abandon their stalks and take to a free life, first made their appearance during this epoch.

Ordinary Star-Fishes (*Asteroidea*) and Brittle-Stars (*Ophiuroidea*) were of increasing importance, and very numerous Sea-Urchins (*Echinoidea*) existed, many of them resembling recent forms, and differing greatly from the primitive palæozoic types.

MESOZOIC LAMP-SHELLS (BRACHIOPODA).—These lost their dominance during this epoch, and the most important species belonged to genera which are represented at the present day (e.g. *Terebratula* and *Rhynchonella*).

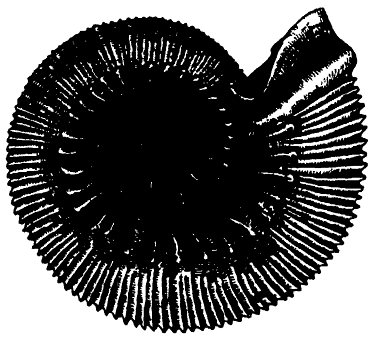


Fig. 1321.—Shell of an Ammonite (reduced)

MESOZOIC JOINTED-LIMBED ANIMALS (ARTHROPODA).—The Trilobites and Eurypterids of the Palæozoic epoch were entirely unrepresented, but undoubted *Crustaceans* (*Crustacea*) were common. These included numerous species belonging to the highest order (*Decapoda*), and more or less resembling the Lobsters, Prawns, Shrimps, and Crabs of the present day.

Among the air-breathing forms *Insects* (*Insecta*) were gradually acquiring a dominant position. Of orders for the first time represented may be mentioned Beetles (*Coleoptera*), Flies (*Diptera*), and Membrane-Wings (*Hymenoptera*). Ants are the most ancient members of the last order, so far as the evidence goes.

MESOZOIC MOLLUSCS (MOLLUSCA).—*Head-Footed Molluscs* (*Cephalopoda*) took a leading place in the marine fauna. Two important types, *i.e.* Ammonites and Belemnites, were practically limited to the epoch. The former (fig. 1321) possessed spiral chambered shells, with the turns in one plane, and the edges of the partitions between the successive chambers elaborately folded. Towards the end of the epoch, however, we find more or less

unrolled species (fig. 1322), some even that were perfectly straight. Such types may perhaps be regarded as unsuccessful attempts at adaptation to changing surroundings. The Belemnites (fig. 1323) possessed internal shells, and in this and some other respects, *e.g.* the possession of an ink-bag, resembled recent Cuttle-Fishes, though they belonged to a distinct group. Cuttle-Fishes and Squids, which are now dominant members of their class, were feebly represented in Mesozoic times, but as they alone proved able, mainly by acquiring a rapid mode of swimming, to fully adapt themselves to their environment, they finally succeeded in almost entirely supplanting the more ancient types related to them.

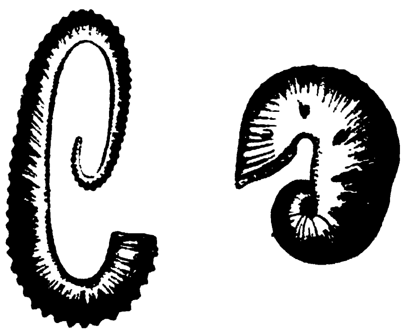


Fig 1322.—Unrolled Cephalopods related to Ammonites (*Hamites* left, *Scaphites* right), reduced

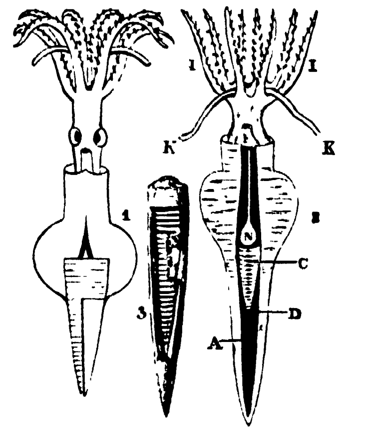


Fig. 1323.—Belemnites (reduced). 1 and 2, Restorations. A D C, internal shell. F, funnel; I I, short arms. K K, long arms; N, ink-bag; 3, shell.

Although many of the primitive palæozoic types of marine *Snails* (*Gastropoda*) were able to maintain their foothold during this epoch, the leading place was taken by specialized carnivorous forms, which became more numerous and varied as time went on.

Bivalves (*Lamellibranchia*) played a much more important part than in the preceding epoch, many new and more advanced types coming into existence. The families now represented by Oysters, Cockles, Mussels, and Razor-Shells, among many others, first made their appearance.

Mesozoic Fishes (Pisces).—The last marine representatives of existing *Lung-Fishes* (*Dipnoi*) existed in the earlier part of the epoch, and some of the fossil teeth are so like those of the Queensland Lung-Fish (*Ceratodus*) as to suggest a close relationship with that form. There were many mesozoic *Sharks*, &c. (*Elasmobranchii*), and we can trace the gradual specialization of

their flattened relatives, the Skates and Rays. *Ganoids* (*Ganoidei*) abounded, and some of them appear to have been ancestral to Sturgeons.

Ordinary Bony Fishes (*Teleostei*) are the dominant members of their class at the present day, and date back to the later stages of the Mesozoic epoch. Some of the older types, less well adapted than they to an aquatic life, have gradually declined since the time of their first appearance.

MESOSOIC AMPHIBIANS (AMPHIBIA).—The armoured Amphibians (*Stegocephala*) of the palæozoic lived on into the earlier part of this epoch, to which belonged the largest known member of the order (*Mastodonsaurus*), the head of which was about four feet long. The teeth and footprints (fig. 1324) of this and related forms were characteristic, and have been known to geologists for a comparatively long time. The former were conical, and exhibit in cross-section very elaborate folds of enamel, which suggested the name of "Labyrinthodon" (*i.e.* labyrinth tooth). The footprints look something like the impressions of clumsy hands, hence the old name "Cheirotherium" (*i.e.* hand-animal).

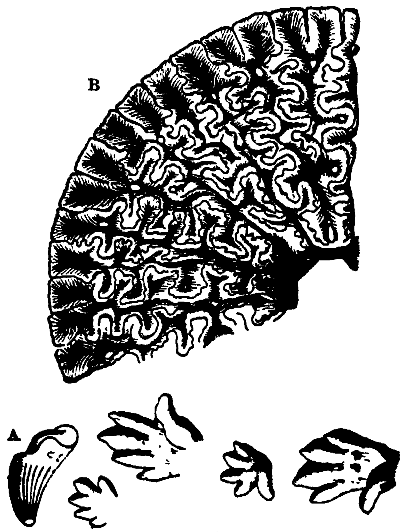


Fig. 1324.—Labyrinthodon. A, Tooth and footprints (reduced); B, part of cross-section of tooth (enlarged).

MESOZOIC REPTILES (REPTILIA).—The ancient order (*Rhynchocephala*), of which the Tuatara (*Hatteria*) is the only living representative, includes a number of species which were widely distributed in the early part of this epoch. Some of them were as much as 6 feet in length.

One of the most interesting extinct orders of the class, the *Varied-Toothed Reptiles* (*Anomodontia*) includes characteristic land-forms which lived during the later part of the Palæozoic epoch and the earlier part of the Mesozoic. The interest attaching to them lies in the fact that in certain respects they were intermediate in structure between the Armoured Amphibians and the lower Mammals, so that they probably represent the stock from which the last class has taken origin. Among mesozoic types may

be mentioned the following:—Pareiasaurus (fig. 1325), a particularly clumsy-looking creature some 8 feet long and between 2 and 3 feet high; Cynognathus, with skull and teeth not unlike those of a dog; and Dicynodon, possessing large tusk-like upper canines.

The five extinct orders of Reptiles now to be mentioned were

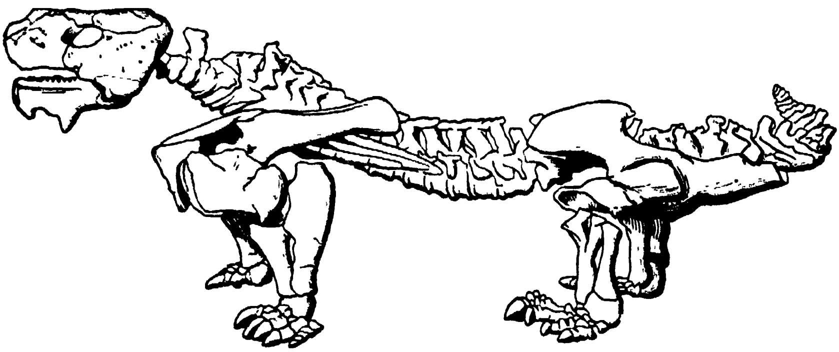


Fig. 1325.—Pareiasaurus (much reduced)

represented by a large number of forms peculiar to the epoch, and severally adapted to the most various conditions of life, in the sea, on the land, and even in the air.

Fish-Lizards (*Ichthyosauria*).—These were large rapacious marine forms, something like whales in shape, and with paddle-like limbs (fig. 1326). Judging from their enormous eyes they

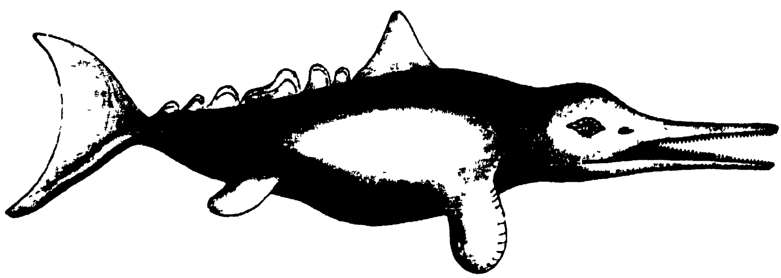


Fig. 1326.—Restoration of Fish-Lizard (*Ichthyosaurus*), much reduced

were of nocturnal habit. Another interesting feature was the unsymmetrical tail, with the larger lobe below. The shape of this would facilitate return to the surface after diving (see vol. iii, p. 289).

Sea-Lizards (*Plesiosauria*).—These also were marine reptiles with large paddles, and the most familiar types (e.g. *Plesiosaurus* fig. 1327) possessed a long almost swan-like neck. The earlier members of the order appear only to have been semi-aquatic.

Sea-Serpents (*Pythonomorpha*).—During the later part of the epoch the marine reptiles belonging to the last two orders diminished in numbers and importance. They were to some extent replaced by the snake-shaped creatures of the present group, with small short paddles. Some of the largest forms (*Mosasaurus*) seem to have been as much as 49 feet in length.

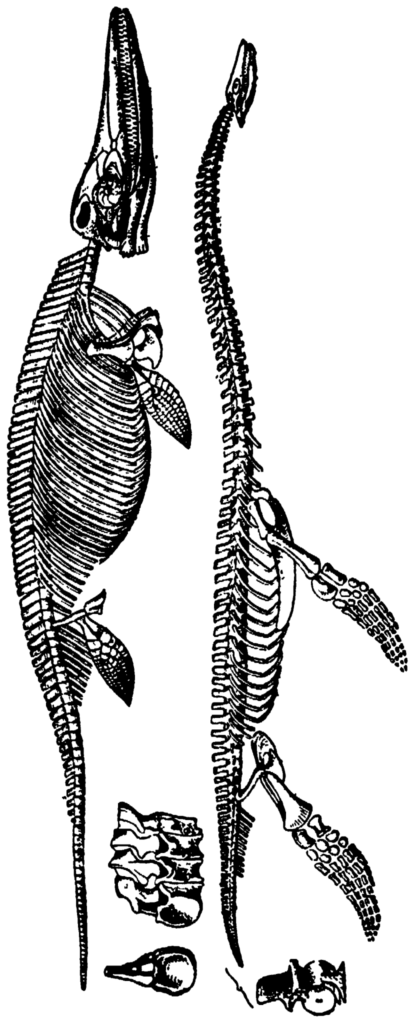


Fig 1327.—Skeletons of Fish-Lizard (*Ichthyosaurus*) and Sea-Lizard (*Plesiosaurus*), much reduced

Terrible Reptiles or Dinosaurs (*Dinosauria*).—The members of this varied group were the dominant land-reptiles of the epoch, and were represented by a great variety of remarkable species. The Reptile-Footed Dinosaurs (*Sauropoda*) were herbivorous forms with hoof-bearing plantigrade extremities. Some of them attained a very large size, the most gigantic (*Atlantosaurus*) is even believed to have been as much as 115 feet long. The Beast-footed Dinosaurs (*Theropoda*) were of carnivorous habit, and distinguished by the great proportionate length of their hind-limbs, which suggests that hopping was their typical mode of locomotion. They included species of greatly differing size, from that of a cat to that of an elephant. The Armoured Dinosaurs (*Stegosauria*) were herbivorous creatures, and in the type-genus (*Stegosaurus*, fig. 1328), which included species some 28 feet long, the back was protected by a series of large flattened bony plates, passing into spines on the upper side of the tail. The head was of relatively small size, and the brain so tiny that the intelligence must have been small. The herbivorous Bird-Footed Dinosaurs (*Ornithopoda*) are so-called because the structure of their hind-limbs

presents some points of resemblance to birds, probably due to their having been adapted to the same kind of locomotion on

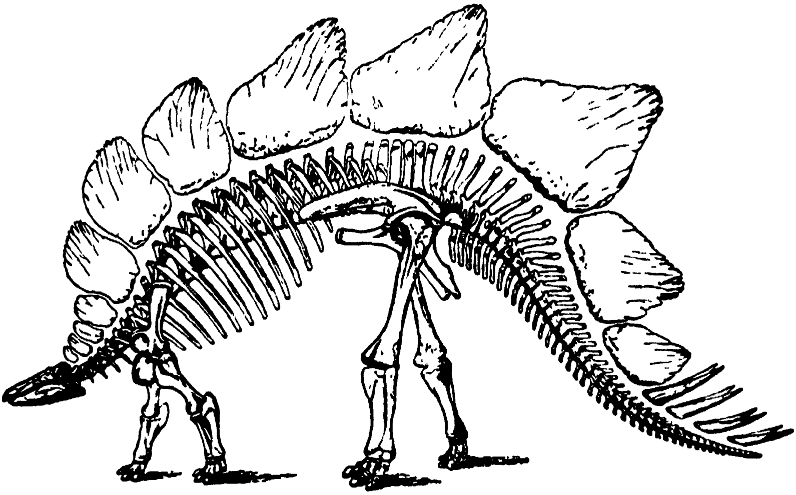


Fig. 1328.—Stegosaurus (much reduced)

the ground. These limbs were relatively very long, and they were also digitigrade, *i.e.* the animals possessing them walked on tiptoe. The best-known member of the group (*Iguanodon*, fig. 1329) inhabited England, Belgium, and Germany during the second half of the Mesozoic epoch, and the larger of the two known species was nearly 30 feet in length. The Horned Dinosaurs (*Ceratopsia*), which were among the later forms of the epoch, included a remarkable herbivorous creature (*Triceratops*) over 20 feet in length, with three horns on the head, and a curious bony shield covering the neck.

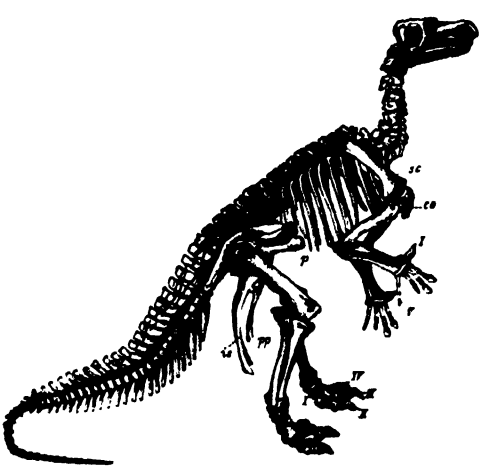


Fig. 1329.—Iguanodon (much reduced). *sc*, Scapula, *co*, coracoid, I and V (in fore-limb), thumb and little finger, *p* pubis produced back into post-pubis (*pp*), *is*, ischium. I–IV (in hind-limb), 1st to 4th toes.

Flying Reptiles (*Pterosauria*).—The organs of flight of these extraordinary animals have elsewhere been described (see vol. iii, p. 308). Some were of small size, and of these the Pterodactyles (*Pterodactylus*,

fig. 1330) were short-tailed. But one of the later types (*Pteranodon*) was a toothless reptile with a spread of wing not far short of 20 feet.

Crocodiles (*Crocodilia*) and *Turtles* (*Chelonia*) were numerous during the Mesozoic epoch, and in the later part of it both *Lizards* (*Lacertilia*) and *Snakes* (*Ophidia*) are known to have existed.

MESOZOIC BIRDS (AVES).—The few mesozoic birds which have so far been discovered have certain characters, *e.g.* the possession of teeth, which suggest reptilian descent. In the oldest known form (*Archæopteryx*), which has elsewhere been described (see vol. iii, p. 296), the tail was long, and bore pairs of quill-feathers at regular intervals.

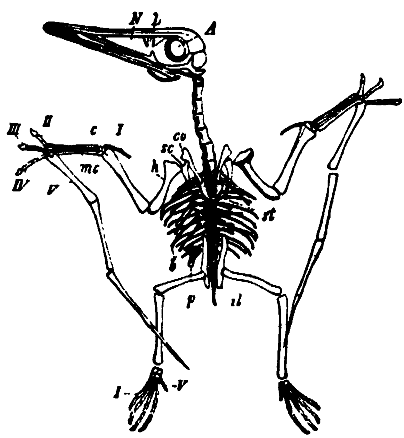


Fig. 1330.—Pterodactyle (*Pterodactylus*), reduced. A, Eye; L, lachrymal bone; *sc*, scapula; *co*, coracoid, *h*, humerus; *c*, carpus, *mc*, metacarpus, I–V (in fore-limb), thumb and fingers; *st*, sternum, *b*, abdominal ribs; *p*, pubis, *il*, ilium, I–V (in hind-limb), toes.

MESOZOIC MAMMALS (MAMMALIA).—That a certain number of small mammals lived during the Mesozoic epoch is known from the discovery of fossil lower jaws in several localities. Some of these suggest affinity with Egg-laying Mammals (*Monotremata*), while others probably belonged to small Pouched Mammals (*Marsupialia*). It has been suggested that Mammals evolved from some of the Varied-Toothed Reptiles (*Anomodontia*) on a land-area in the southern hemisphere, which there is some reason to believe once existed (see p. 411). Smith Woodward (in *Vertebrate Palæontology*) states that in Jurassic (*i.e.* mid-mesozoic) times—" . . . it is extremely probable that on some continent in that part of the globe the Anomodontia were gradually being transformed into Mammalia. At least, in the Jurassic formations both of Europe and North America there are occasional remains of small mammals as large as rats; and the most plausible explanation of these is, that they were accidental escapes from some other region with a more advanced fauna, just as are the rats and mice of the present day in the comparatively antique realm of Australia."

LIFE IN THE KAINOZOIC EPOCH

Even in the earlier stages of the Kainozoic epoch we find that the fauna had a comparatively modern aspect, and the later stages ultimately merge into the present. Among backboned land-animals Mammals and Birds were dominant, and it will be as well to confine our attention to a few interesting facts concerning these groups.

KAINOZOIC MAMMALS (MAMMALIA).—The fossil remains which have so far been examined enable us to trace the gradual evolution of the subdivisions of several mammalian orders, notably

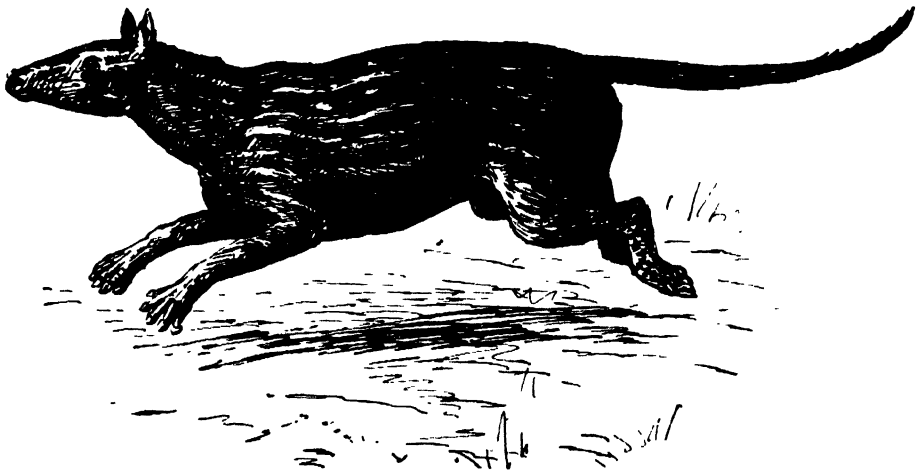


Fig 1331.—Restoration of Phenacodus (reduced)

so as regards *Hoofed Mammals* (*Ungulata*) and *Flesh-Eaters* (*Carnivora*). In the earliest stage of the epoch we find the ancestors of the hoofed forms represented by small primitive swamp-dwellers, constituting an extinct group (*Condylarthra*), of which a well-known type (*Phenacodus*) is represented in figs. 1331 and 1332. By increasing complications of structure, affecting limbs, teeth, brain, &c., the various odd-toed and even-toed ungulates have sprung from creatures of the kind, as also *Conies* (*Hyracoidea*), and, most probably, *Elephants* (*Proboscidea*). The nature of some of the specializations which took place have been briefly explained in a previous section (see vol. iii, p. 137).

What is true for Hoofed Mammals as regards one primitive group is also true for Flesh-Eaters with reference to another such group (*Creodonta*). Indeed there is not a great deal

AN EXTINCT GROUND-SLOTH (*Megatherium*)

It is a remarkable fact that certain groups of land-animals were in part represented, in comparatively late geological times, by gigantic forms which have since become extinct. This is the case, for example, with the Mammals poor in Teeth (*Edentata*), to which belongs the South American Ground-Sloth (*Megatherium*) represented in the plate, which is taken from a photograph of a restoration in the British Museum. In size it was nearly as large as an elephant, and is believed to have fed on leaves, as do the relatively insignificant Sloths which now live in the trees of the South American forests. The plate represents the Ground-Sloth in the position it assumed for the purpose of pulling down branches, or uprooting small trees, in order to obtain its food.

EXTINCT SOUTH AMERICAN GROUND-SLOTH (MEGATHERIUM)

of difference between the early kainozoic ancestors of Ungulates and Carnivores, both of which undoubtedly sprang from the same mesozoic stock, though this is as yet unknown. In similar fashion we find that the lines of descent of recent *Insect-Eaters* (*Insectivora*), *Lemurs* (*Lemuroidea*), and *Monkeys* (*Primates*) converge as we trace them back to the beginning of the epoch. The branches of the genealogical tree of mammals corresponding to the last two groups actually meet, and on this account some experts would place the Lemurs in the same order as Monkeys (*Primates*). We further find that the lines of descent of Insectivores, Lemurs, and Monkeys converge towards those of the Ungulates and Carnivores, and this appears to be also true for the *Mammals Poor in Teeth* (*Edentata*). Some day, perhaps, we may be able to trace back all these six orders, together with Conies and Elephants, to common mesozoic ancestors.

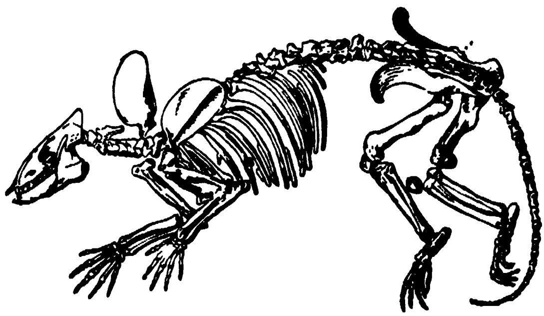


Fig. 1332 —Skeleton of Phenacodus (reduced)

Whales, &c. (*Cetacea*), *Sea-Cows* (*Sirenia*), *Gnawers* (*Rodentia*), and *Bats* (*Chiroptera*) seem to have acquired their typical characters before the Kainozoic epoch began, and we are not yet able to trace them back to the main line of mammalian descent. The two first groups, and creatures of the seal kind, replaced the marine reptiles of Mesozoic time in the life of the sea, and the Flying Reptiles proved unable to maintain their supremacy against the competition of Bats and Birds.

In the later part of the Kainozoic epoch certain orders of mammals were represented by relatively gigantic forms. A good instance of this is afforded by certain extinct American representatives of the *Mammals Poor in Teeth* (*Edentata*). At this time South America and the southern part of the sister continent were inhabited by huge Ground-Sloths, of which one typical form (*Megatherium*) was at least as large as an elephant. It and its allies combined some of the structural features of existing Sloths and American Ant-Eaters. That so large an animal as the one mentioned was not a climber is sufficiently obvious.

It is supposed to have been a leaf-eater, pulling off branches, or even uprooting small trees. A related form (*Mylodon*), which attained the size of a rhinoceros, possessed an external skeleton consisting of small bony plates imbedded in the skin. Remains of the skin, &c., of an allied type (*Neomylodon*) were not long since discovered in a South American cave, and in so fresh a state as to warrant a belief in the animal's recent extinction, while some naturalists, partly on the strength of native traditions, believe (or at any rate hope) that the creature still lives in the desert regions of Patagonia. Gigantic Armadilloes, of which one type (*Glyptodon*) was about 16 feet in length, inhabited America in comparatively late Kainozoic times.

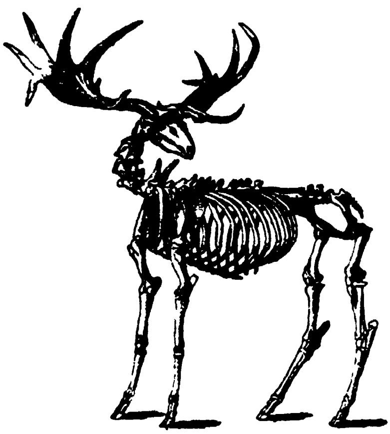


Fig 1333.—Irish Elk (*Cervus Hibernicus*), much reduced

Turning to Australia, we find that some of the immediate predecessors of the *Pouched Mammals* (*Marsupialia*) of that continent attained large dimensions. The skull of the Pouched "Lion" (*Thylacoleo*), a form related to the existing Phalangers, was about 9 inches long. Its name is rather unfortunate, for it was probably of vegetarian habit. Very much larger than this was a gigantic animal (*Diprotodon*) related both to the Phalangers and Kangaroos, for it was about as large as a rhinoceros, its skull alone being over 3 feet in length. Its limbs were adapted for walking.

Three large extinct Mammals have a special interest as being contemporaneous with prehistoric Man in Western Europe, including Britain. One was the Irish "Elk" (*Cervus Hibernicus*, fig. 1333), remains of which are not uncommon in the peat-bogs of Ireland. The female possessed no antlers, but the male was well-endowed in this respect, for in him these weapons sometimes had a spread of about 10 feet. The Sabre-Toothed Tiger (*Machairodus*) belonged to a group of Flesh-Eaters now extinct, and possessed enormous upper tusks, which are responsible for its name. The lower tusks were quite small. It seems that the huge weapons of creatures of the kind were too well developed to be of much use, probably indeed acting as encum-

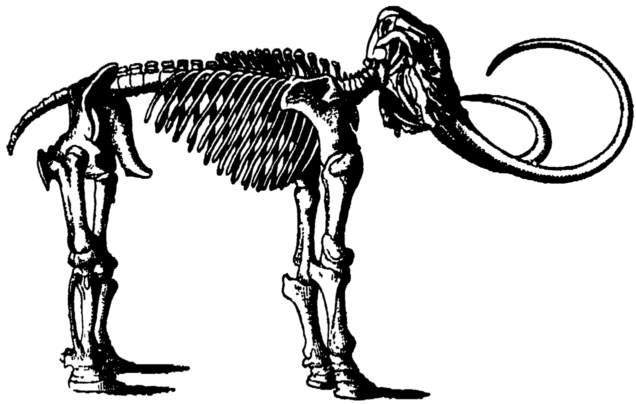
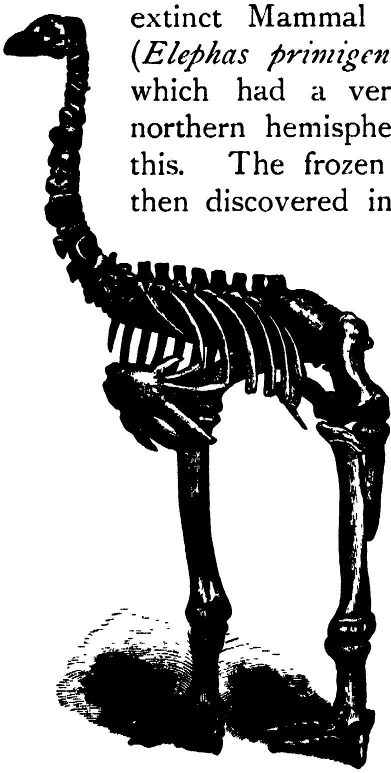


Fig. 1334.—Mammoth (*Elephas primigenius*), much reduced

brances which in the end brought about extinction. Here, as in many other cases, over-specialization proved fatal. The last extinct Mammal to be mentioned is the Mammoth (*Elephas primigenius*, fig. 1334), a sort of Elephant which had a very wide geographical range in the northern hemisphere, especially in the colder parts of this. The frozen bodies of Mammoths are now and then discovered in the iron-bound soil of the Siberian tundras, and these prove the existence of a thick coat of long black over-hair, together with reddish wool, a character no doubt to be regarded as a climatal adaptation. One of the prehistoric drawings made by the men of the Stone Age (see p. 233) gives a rough outline of one of these animals, and indicates the shaggy coat. It was found in a French cavern, and executed upon a piece of mammoth tusk. The Siberian variety has long been known as a source of fossil ivory.



g. 1335.—Skeleton of Moa (*Pachyornis elephantopus*), much reduced

Kainozoic Birds (*Aves*).—Some of the extinct *Running Birds* (*Ratitæ*) are perhaps the most interesting. In New Zealand, for example, the Moas existed during the period of human occupation, and were finally exter-

minated by the Maoris. The largest form (*Dinornis maximus*) attained a height of over 11 feet. Another sort of Moa (*Pachyornis elephantopus*, fig. 1335), though not so large as this, was much more massive in build. Egg-shells and feathers of these birds have been found, as well as skeletons. The bones and egg-shells of other large running birds (*Æpyornis*) have been abundantly discovered in Madagascar, and it is not unlikely that they too owed their extinction to human agency. Some species were little inferior in size to the largest Moas. It is not improbable that the creation of the fabulous bird known as a "roc", which figures in the Arabian Nights and other Eastern stories, was originally based upon ancient traditions regarding some of the extinct running birds.

At the present time such birds are limited to the soutnern hemisphere, but we know that during early Kainozoic times they also existed in the northern half of both Old and New Worlds.

PHILOSOPHIC ZOOLOGY

CHAPTER LXXVIII

PHILOSOPHIC ZOOLOGY—THE THEORY OF EVOLUTION —EVOLUTION AS A FACT

Having now considered at some length the relations of animals to their surroundings (or environment), in which, of course, other organisms are included, and having also reviewed the life-cycles or life-histories of certain typical forms, this work may be fitly concluded by a brief survey of the Theory of Evolution, which at the present day not only dominates the realm of Natural History, but has also had a far-reaching influence upon almost every branch of learning.

The kinds or *species* of animal at present existing are almost innumerable, and we know from the geological record that a host of others once lived which are now extinct, some having become so within the historic period, while others died out millions of years ago. Until the second half of last century it was commonly believed that all these species came into existence by "special creation", and to ask "why?" any kind of animal had a particular structure, developed after a special fashion, exemplified certain habits, or lived in a definite area, was considered undesirable or even impious. The only answer to such questions given by the doctrine of special creation was that these things were so because they had been designed to be so, according to a plan into which the human mind was forbidden to pry. Now and then, however, from the time of Aristotle onwards, this paralyzing dogma failed to satisfy the minds of certain naturalists who were ahead of their times. Among these perhaps the most notable was the eminent French zoologist Lamarck, who in 1801 expressed the view that all existing species have descended from, *i.e.* been evolved from, pre-existing

species. He further propounded a Theory of Evolution, which attempted to explain *how* species have originated from those which preceded them. But comparatively little attention was paid to the evolutionary views of Lamarck and some other naturalists till the year 1858. In that year a new Theory of Evolution (now commonly known as Darwinism) was simultaneously propounded by Charles Darwin and Alfred Russel Wallace, who, working independently on facts collected in entirely different parts of the world, had reached practically the same conclusions regarding the manner in which organisms of different kind have come into existence. The publication of Darwin's epoch-making book, *The Origin of Species*, followed in 1859, and since that date the doctrine of evolution has made steady headway, at first against strong and even embittered opposition, until now the doctrine of special creation is almost entirely held by those who have had no scientific training worthy the name, together with some few others who cling tenaciously to the old and once popular view.

This chapter is concerned with the *fact* of Evolution, and not with the various theories associated with the names of Darwin and many others which attempt an explanation of that fact. The distinction between the fact and its explanation is of importance in a popular work like this. Botanists and zoologists, after the manner of their kind, are constantly engaged in polemics about all sorts of evolutionary problems, their controversies being often not a little acrimonious, and sometimes even taking a personal turn. These things, however, are not unknown among the votaries of other studies. But in such cases it is not the fact of evolution that is in question, but this or that difficult question as to the way in which it has come about. All are agreed that evolution and not special creation has been and is the primary law of organic nature, probably, indeed, of nature in general.

Since the whole of this book has been written from the evolutionary stand-point, much has already been adduced in support of the fact of evolution, and it will therefore suffice to summarize some of the chief arguments in its favour, following the order adopted by Romanes (in *Darwin and After Darwin*).

THE ARGUMENT FROM CLASSIFICATION.—If the various kinds or species of animal were absolutely separate creations we should expect to find them clearly distinguishable from one another,

but this is by no means universally the case. Indeed, it is by no means easy to exactly state what a species is. Some such definition may be given, for example, as the one by Swainson:—"A species, in the usual acceptation of the term, is an animal which, in a state of nature, is distinguished by certain peculiarities of form, size, colour, or other circumstances, from another animal. It propagates, 'after its kind', individuals perfectly resembling the parent; its peculiarities, therefore, are permanent." But unfortunately there are such things as *varieties* or *races*, which are subdivisions of species, and might be taken for such if seen in a museum. In the case of the Field Snail (*Helix hortensis*), for example, there are many such races, distinguished by variously coloured and banded shells. But in cases like this we usually find that the different varieties, when crossed, produce offspring (mongrels) which are perfectly fertile as regards one another and the parent varieties. On the other hand, the offspring (hybrids) produced by crossing two undoubted species are usually, but not always, infertile. A notable instance is seen in mules, which are obtained by crossing horses (*Equus caballus*) with asses (*E. asinus*). We further find that two or more apparently distinct species may be connected by a series of intermediate varieties. This is beautifully seen in some of the extinct Lamp-Shells and Snails, while the early turns of the spiral in some Ammonites (see p. 465) may resemble one adult species, though the later turns may correspond to another adult species. Facts of the kind cited, while only susceptible of interpretation in a mystical manner by the doctrine of special creation, harmonize very well with the evolution theory, according to which organisms are constantly being adapted to changing surroundings, and new specializations are continually coming into existence. On this hypothesis we may regard varieties as species "in the making".

Species are aggregated into larger groups known as genera, these into families, and so on, to orders, classes, and phyla or sub-kingdoms, respectively marked out by agreements and differences of increasingly broader and more general kind. If these various groups of, *e.g.*, Backboned Animals, are diagrammatically arranged so as to best express their mutual arrangements, a tree-like arrangement results (see vol. i, p. 111), the phylum corresponding to a main branch. This was perceived in pre-evolutionary days, and the only rational explanation so far given

of it is that such a tree is really a genealogical one. The conclusion is fully confirmed by the geological record.

We also find a number of existing animals which, though on the whole susceptible of classification in one group, also show points of marked agreement with members of one or more other groups. A notable instance is afforded by Peripatus (see vol. i, p. 398), which, though an undoubted Arthropod, is singularly like a segmented Worm or Annelid in some respects. If the classification tree is a genealogical one, the existence of such animals is readily intelligible. Such cases are otherwise inexplicable, unless some unintelligible and dogmatic statement offered by the believer in special creation can be so regarded.

The Argument from Form and Structure (Morphology).—A very large number of examples might be brought forward to show that many organs can only be rationally interpreted on an evolutionary basis. A particularly good instance is afforded by the lungs of air-breathing vertebrates, which appear to be modifications of the swim-bladders possessed by fishes (see vol. ii, p. 421). And it may be added that there are many other structural characters of these air-breathing forms which point to an aquatic ancestry. That this should be so, is only intelligible from the stand-point of evolution.

If we take a particular group of animals, say Mammals, we shall find that they are constructed on a particular plan, modified in a great variety of ways to suit the exigencies of various modes of life. This is very well illustrated by the structure of the limbs, in reference to different kinds of locomotion, *e.g.* swift progression by running on a firm surface, swimming, climbing, and burrowing, as set out in detail in the section on Locomotion (vol. iii). We have here, it would appear, a gradual Adaptation by a process of evolution to conditions of different kind.

The strongest argument from structure in favour of the doctrine of evolution is that derived from those parts of animals which are known as *vestiges* (rudimentary organs). The human body, for example, is in itself quite a museum of such structures. Indeed, one may say that it is an archæological museum, for vestiges can only be reasonably explained as the remains of organs which were of greater importance in ancestral forms. The lower end of the backbone (coccyx), for instance, looks uncommonly like the remains of what was once a tail, and the

same explanation can be given of the tailless condition of the man-like or anthropoid apes (Gorilla, &c.). The troublesome little outgrowth from the intestine familiarly known as the "appendix", which when diseased leads to appendicitis, corresponds to what is a large and useful structure in some other Mammals; and a little red fold (semilunar fold) in the inner corner of the eye appears to be the remnant of a third eyelid. And so on, almost indefinitely. Among Mammals other than

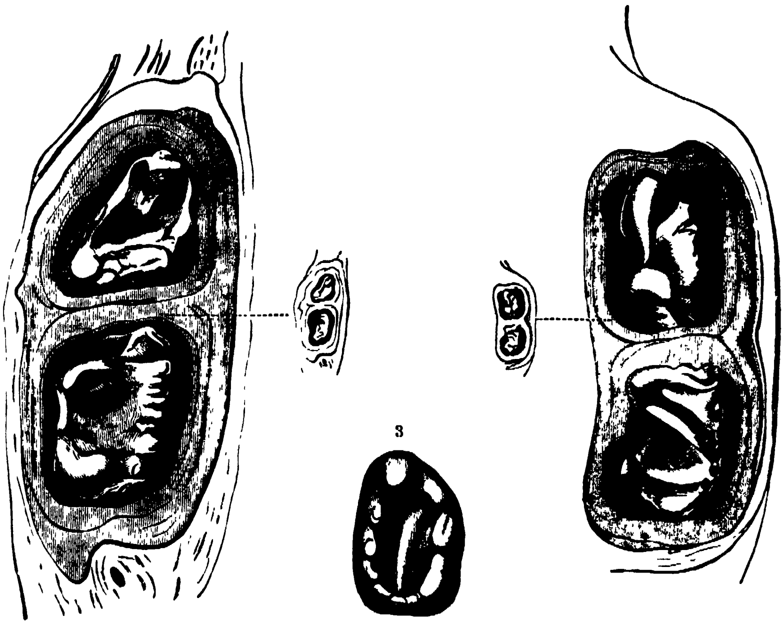


Fig. 1336.—(1) and (2), Upper and lower grinding-teeth of a young Duck-Bill (*Ornithorhynchus*), natural size and enlarged; (3) grinding tooth (enlarged) of an extinct Mesozoic mammal (*Microlestes*).

ourselves we find a great variety of vestiges. Whalebone Whales, to take a well-known case, possess neither teeth nor externally visible hind-limbs. But traces of teeth are found in the jaws of very young individuals, although they are never cut. And vestigial hind-limbs are found even in adults, imbedded in the muscles of the hinder part of the body, exactly where hind-limbs should be were they fully developed. Unless we simply accept these things as inexplicable facts, we must fall back on the doctrine of evolution, and consider such structures as dwindled heritages, reminiscent of earlier conditions.

Passing from the higher Mammals to their lowest existing

relatives, we find in the Australian Duck-Bill (*Ornithorhynchus*) that the adult animal possesses four horny plates in place of teeth. But these are preceded by small molars (fig. 1336) which last for a short time only. The conclusion may be drawn that the Duck-Bill is descended from ancestors which possessed teeth when adult. And, in connection with this, it is interesting and significant that the transitory teeth of this creature are singularly like those possessed by an extremely ancient Mesozoic mammal, which has been extinct for an enormous length of time.

ARGUMENT FROM DEVELOPMENT.—As already explained in the section on Development and Life-History (vol. iii), an animal of complex structure results from a process of gradual up-building, in which the ovum or egg-cell is the first and simplest stage. Speaking very broadly, the course of this development is taken to be a recapitulation of the history of the group to which the particular animal belongs. The life-history of a particular form may, for example, include stages adapted to different modes of life, and in some cases these apparently correspond to ancestral stages similarly adapted. We see this in the Frog, which is hatched out as an aquatic tadpole, breathing by gills and fitted in various other ways for life in water. From this the conclusion is drawn that the remote ancestors of Frogs were aquatic creatures, related to the stock from which recent fishes have descended. The argument may be extended to Reptiles, Birds, and Mammals, for though these do not begin life as aquatic tadpoles, all of them possess gill-slits during certain stages in their development. But these slits have nothing to do with breathing, apparently serving no useful purpose, and ultimately close up. One result of their presence in the embryo is that some of the blood-vessels develop in a somewhat roundabout manner (see vol. i, p. 244). These vessels begin in conformity to what may be called the "fish-plan", abandoning this later on for the arrangement characterizing the air-breathing adult. Such a peculiar method of development is quite unintelligible unless it is explained by reference to ancestry.

The Feather-Star (*Comatula*) furnishes a striking example of recapitulation in its life-history. It is for some time fixed to some firm object by means of a stalk, which is later on abandoned. This may very reasonably be taken to mean that

Feather-Stars have descended from fixed forms resembling the related Sea-Lilies, some of which still live in the deep sea.

THE ARGUMENT FROM THE GEOLOGICAL RECORD.—Although our knowledge of the successive faunas which have existed in the course of the earth's history is lamentably incomplete, all the facts with which we are acquainted harmonize with the doctrine of evolution (see p. 456). There has been a general progress from low to high, and many animal pedigrees have been worked out in considerable detail. Taking Hoofed Mammals and Flesh-Eaters, for instance, the geological record shows that the existing subdivisions of these orders can be traced back, respectively, to common ancestors (see p. 472). The most ancient birds known possess characters which are strong evidence of reptilian descent, and Reptiles, in their turn, are in all probability an offshoot from an amphibian stock. Similar evolutionary conclusions can be drawn in all cases where sufficiently abundant evidence is available.

THE ARGUMENT FROM GEOGRAPHICAL DISTRIBUTION.—The way in which animals are at the present time distributed over the face of the globe is susceptible of no satisfactory explanation unless we have recourse to the theory of evolution. Admitting this, and at the same time making full use of the evidence afforded by the geological record, many things which would otherwise be entirely unintelligible find an easy solution, as has already been sufficiently indicated (see p. 409). We are able in this way to understand why Tapirs are at the present time only to be found in south-east Asia and tropical America, Pouched Mammals in the Australian region and America, and similarly for many other apparent anomalies.

CHAPTER LXXIX

THE THEORY OF EVOLUTION—THE ORIGIN OF SPECIES

If we admit that the existing kinds or species of animals have arisen by a process of evolution from pre-existing species, the pertinent question "How?" demands an answer. Our ignorance is here so profound that we have so far only been able to frame working hypotheses to account for the facts. And every theory from time to time propounded leads to endless controversy, though, on the whole, we are constantly getting nearer to the heart of things. Everything depends upon the properties and possibilities of the living substance (protoplasm) which is the essential part of every organism, but it is precisely here that the gaps in our knowledge are most painfully obvious. The history of every science presents us with regularly alternating phases of fact-collection, and generalization upon facts. At the present time we badly need more facts, upon which to base further speculations as to the methods of evolution. And this is more particularly true regarding experiments on heredity and related matters, upon which satisfactory answers to evolutionary questions must necessarily depend.

We are here only concerned with a brief statement of the leading theories and principles which have so far been brought forward, commencing with the doctrine of Natural Selection, simultaneously advanced by Darwin and Wallace, and which has had a quite unprecedented influence upon the methods of human thought.

NATURAL SELECTION (DARWINISM)

This theory of evolution, which is essentially of utilitarian character, marshals together a large number of indisputable facts, suggests their mutual relations, and builds up, step by step, a very convincing hypothesis as to how and why new species have

come into existence during the countless ages for which life has existed on the earth.

It is, to begin with, sufficiently obvious that the available living space on the earth is, after all, restricted, and there must therefore be a limit to the number of plants and animals that can exist at the same time. We know, however, that all organisms tend to increase in a more or less rapid manner, yet, in a given locality, the numbers of individuals belonging to a particular species remain fairly steady. There must, therefore, be various checks preventing indefinite increase—a constant fight for life, a Struggle for Existence. Every plant and every animal is engaged in a keen competition with other forms of life, and has also to battle with the constantly-changing physical conditions which collectively constitute climate. Individuals that for any reason surpass others in this constant warfare with their surroundings are, so to speak, *selected* by Nature to carry on their race, while their less fortunate fellows go to the wall. We have, in short, the active principle of Natural Selection or Survival of the Fittest.

We have further to consider how and why it is that given individuals are thus favoured in the universal struggle for existence. The classes of facts which give us some insight into this matter may be conveniently arranged in the following tabular statement, followed by a brief discussion of the principles involved.

PROVED FACTS	NECESSARY CONSEQUENCES
Limited Surface of Globe and Rapid Increase in Numbers	Struggle for Existence
Struggle for Existence and Variation	Natural Selection or Survival of the Fittest
Natural Selection and Heredity ...	Origin of New Species

RAPID INCREASE IN NUMBERS.—Darwin takes the elephant as an example of an animal of which the numbers increase with minimum rapidity, a family of six within the space of 60 years being the average, while individuals live for about a century. Supposing all the offspring to survive for the full tenure of existence, this gives a total of about 19,000,000 elephants descended from a single pair after the lapse of from 740 to 750 years.

As an example of a species which increases with great rapidity

we may take the Field Vole (*Arvicola arvalis*), which produces several broods during the same summer, some of these propagating in their turn before winter. Crampe has calculated that, if there were no checks to increase, a single pair of these animals, supposing their first brood to be born on April 15 of a given year, would be represented by the very respectable total of 198 on the following 8th of October. Continental agriculturists sometimes have a very unpleasant object-lesson as to these possibilities, for in certain "vole years" the ordinary checks to increase are inefficient, the result being that enormous numbers of field-voles make their appearance, and do an immense amount of damage to crops.

It not infrequently happens that when particular species of animals are introduced into a new country, where the checks that keep down their numbers in their native countries cease to operate, they increase in a phenomenal way. The result of introducing rabbits into Australia affords one of the best examples of this.

Variation and Heredity.—It is a well-known fact that no two individuals of the same species are precisely alike. There is, in other words, a tendency to vary. The fact of Variation enables us to understand why certain individuals, rather than others, have a better chance of surviving in the struggle for existence. For in any given environment variations in some directions must more or less favour the animals which possess them. They are, in fact, *useful* variations, tending to greater *fitness* as regards some particular set of surroundings. In many herbivorous animals, for example, in regions where carnivorous enemies abound, it is clear that an individual varying in such a way that its locomotor powers are somewhat better than those of its fellows, will have a better chance of escaping from enemies, and also of securing an abundant supply of food. Other things being equal, it will also be more likely to perpetuate its species than more slowly moving individuals of the same species.

Next comes the question of Heredity. No one disputes the possibility of certain characters being transmitted from one generation to another. The doctrine of Natural Selection involves the view that favourable variations are thus perpetuated, and as, in each successive generation, individuals which continue to vary in favourable directions will have the best chance of surviving,

we can suppose such variations to gradually accumulate until their amount is so large as to constitute a new species.

Darwin's conclusions as to the joint result of variation and heredity were largely based on observations made upon domes-

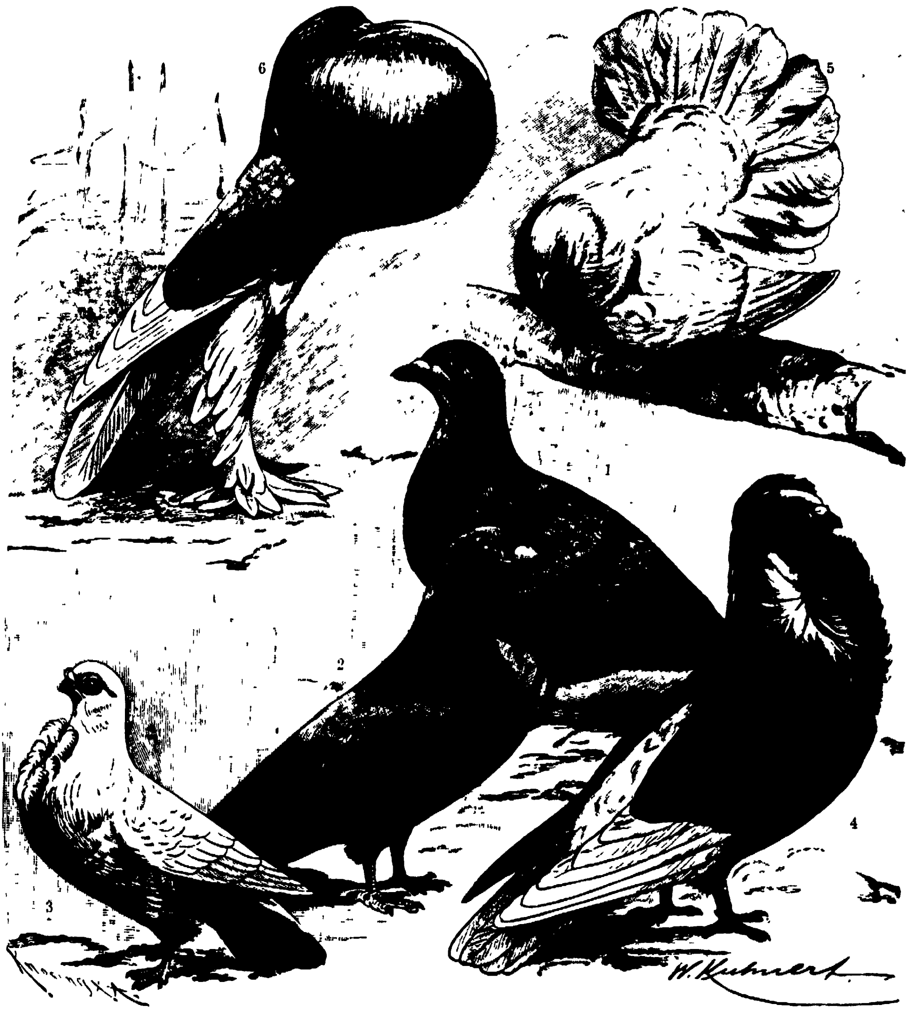


Fig. 1337.—Blue Rock and some of the domesticated varieties of Pigeon: (1), Blue Rock (*Columba livia*); (2), Tumbler; (3), Owl; (4), Jacobin; (5), Fantail; (6), Pouter

ticated animals. We know, for example, that all the numerous breeds of pigeons (fig. 1337), such as Pouters, Fantails, Carriers, Tumblers, &c. &c., are descended from one original species, *i.e.* the Blue Rock (*Columba livia*), as the result of artificial selection by human agency. That is to say, individuals varying in some particular direction have been selected by man with a

view to producing offspring presenting the special character or characters in an increased degree.

Objections to the Theory of Natural Selection.—At various times a number of objections have been made to the theory, some being of a very trifling and quibbling sort, others of more serious nature. It is no part of the plan of this book to enter into all the difficulties that require or have required to be met, and it may suffice to mention one of the most formidable objections, derived from the supposed "swamping effects of intercrossing". That is to say, supposing a favourable variation to have arisen, it seems at first sight that it is just as likely to gradually disappear again by intercrossing as to be emphasized by heredity, indeed more likely. Fleeming Jenkin, the first propounder of this difficulty, illustrated it by the possible case of a white man becoming king of a black island population, his whiteness typifying a favourable variation. His immediate descendants would not be white, but yellow, and in the course of several generations the royal house would probably be just as black as their subjects.

It may be added that if a number of domesticated races of, say, pigeons, are allowed to cross freely together, their peculiar characteristics gradually disappear, and the features possessed by the original wild stock are reacquired. This is generally explained as a case of reversion or atavism, or in more popular language, a "throw back" to the ancestral type.

The objection has been often met by supposing that the particular variation occurred not in one, but in a number of individuals, thus giving a better start for the formation of a new species, but such an idea requires proof. Even if we admit the probability of the occurrence, the factor of Isolation must be emphasized, as has been done by Romanes and others. Isolation of individuals presenting a certain kind of variation would certainly prevent the swamping effect of intercrossing from operating, and pigeon-fanciers, for example, could never succeed in producing new breeds if they did not sort out and keep their birds separate, according to their special requirements. Such isolation actually occurs in nature when a small number of individuals belonging to a particular species reach, say, an oceanic island, where adaptations to a new set of surroundings become necessary, and where they are separated from the original home

of their kind. And it is particularly significant to note, in this connection, that such islands are peculiarly rich in distinct species. Isolation is also exemplified by the area between tide-marks, as in some of the periwinkles. Some of these creatures are gradually becoming adapted to breathing damp air, those which are best off in this respect living near high-water mark. It is pretty clear that individuals varying so as to breathe damp air better than their fellows would naturally take to living further from the sea, and would be thus to some extent isolated.

Isolation may also be of a physiological nature, as emphasized by Romanes in his theory of *physiological selection*. We know that, as a rule, the crosses between allied species, *i.e.* hybrids, are infertile, and it is largely owing to this fact that animal species remain distinct. It seems, therefore, a plausible assumption that the rise of new species has partly been rendered possible by an increasing tendency for the crosses between them and their parent stocks to be infertile. In other words, there has been a physiological variation in the direction indicated, alongside of other variations in shape, proportion, colour, &c. &c.

SUPPLEMENTARY FACTORS OF EVOLUTION

Admitting the importance of Natural Selection, it by no means follows that it has been the only evolutionary factor determining the origin of new species.

Courtship Selection.—Darwin believed that some of the characters of male animals have been brought about by selection exercised on the part of their mates. The possibilities in this direction have already been discussed at some length (see p. 143) in dealing with the Law of Battle and the Law of Beauty. It is, after all, a special kind of Natural Selection, which may have determined the evolution of certain weapons and of æsthetic characters.

Lamarckism.—Under this head may be included the pre-Darwinian views of the French naturalists Lamarck and Buffon, to which Darwin himself was inclined to attach some importance. These views turn upon the inheritance of "acquired characters", regarding which there has been an interminable amount of discussion. It must be premised that the body of an animal higher in the scale than an Animalcule is related to (1)

the existence of the individual, and (2) the existence of the species. The greater part of the body, having more particularly to do with (1), is conveniently termed the "soma" (Gk. *soma*, body), and this is the bearer of germ-cells, some of which are destined to grow into fresh individuals, and are therefore concerned with (2). An "acquired" character is one which comes into existence in the soma, as an accommodation to its mode of life, *i.e.* as an individual adjustment to surroundings. Here have to be considered the results of "use and disuse" of organs possessed by the individual. Let us take, for example, some of the sea-snails which live between tide-marks, and are accommodating themselves to breathing damp air as against air dissolved in water. The gill or gills which are specially concerned with the latter kind of breathing have less work to do than in purely aquatic forms, and there is no reason to doubt that they may therefore (as the result of partial "disuse") be slightly diminished in size in the lifetime of an individual which is migrating towards high-tide mark. On the other hand, the roof of the gill-chamber (see vol. ii, p. 460) has to do with breathing damp air, and in the lifetime of the individual supposed, may well (by "use") acquire increased specialization in connection with that duty.

According to the Lamarckian view, these two acquired characters of the soma, *i.e.* dwindling gill and specializing roof to gill-chamber, would be transmitted to the offspring. Were this so, use and disuse might ultimately lead to the evolution of a race of land-snails well adapted for air-breathing, but with gills shrunk to mere vestiges or absent altogether.

Lamarckism also involves the view that the surroundings of an animal, by their *direct* action, bring about acquired characters, positive or negative, as the case may be. We have, in other words, a direct action of the environment. Considering once more the case of a sea-snail living between tide-marks, it may be regarded as alternately subject to two influences so far as breathing is concerned, *i.e.* the action of the water which covers it for part of its existence, and the action of the damp air which surrounds it during the other part. The former favours gill-retention, the latter gill-reduction, and conversely as regards the arrangement for breathing ordinary air. Near low-tide mark the influence of water is obviously predominant, and near high-tide mark the action of air is more felt.

Some further remarks will be made about acquired characters in the sequel.

NEO-LAMARCKISM.—It is difficult to sum up in a few words the beliefs of the Neo-Lamarckian school. They essentially involve the view that there are general Laws of Growth, leading to progress in definite directions, by means of successive variations of the same kind. The action of Natural Selection is largely discounted.

This chapter may perhaps best be concluded by the addition of a few remarks on Variation and Heredity.

VARIATION

Beyond the fact that living matter *does* vary, we know very little. No clear answer can as yet be given to the questions *why* this should be so, and *how* variations of a given kind are brought about. There can be no doubt, however, that the individuals of any particular species differ from one another in a great variety of ways, and often to a very considerable amount. There is, in fact, an illimitable field for the action of selected principles. Many variations, too, are sudden or *discontinuous*, and probably new species have been often evolved at a much more rapid rate than supposed by Darwin, who believed in the selection and accumulation of *small* variations. Since his time our knowledge of variational possibilities has been largely increased.

There can be no doubt that a large majority of the characters of animals are *adaptations* to the environment, *i.e.* fit them to live in relation to certain surroundings. The origin of such adaptations must naturally be sought in variations. Here it is necessary to clearly distinguish between variations of the soma and variations of the germ, *i.e.* somatic and germinal variation. As we have seen, the Lamarckians believe that the former (acquired characters) can be transmitted. According to the school of Weismann, on the other hand, it is only the germinal variations which are capable of transmission. As, of course, the development of a germ-cell into an individual means the production of a new soma as well as more germ-cells, this new soma will have been influenced by variations which have taken place in the germ from which it has been developed. That is to say, the character of a soma mainly depends upon the char-

acters of the germ from which it has been developed, but the soma has no direct influence upon the germs of which it is the bearer.

Organic Selection.—Lloyd Morgan, Baldwin, and Osborn have elaborated a view (of which Weismann himself suggested the possibility) as to the possibility of co-operation between germinal and somatic variations in the interests of the species. Even if we admit that the latter (acquired characters) are non-transmissible, it by no means follows that they have no evolutionary import. However unimportant the soma may be as to the provision of variations that can be inherited and so help in the making of new species, it is at least the bearer of germ-cells, to which its survival and well-being are of the first importance. If, therefore, it is able to accommodate itself to its surroundings so as to survive and leave offspring, it will give variations which have arisen in its germ-cells a chance of being preserved. Accommodation, *i.e.* the rise of acquired characters, is consequently intimately bound up with the adaptation of the species.

It must not be regarded as definitely settled that acquired characters are never transmitted, although many supposed instances have been explained away. A vast amount of observation and experiment is still necessary, and dogmatism is at present quite out of place.

The question still remains as to whether variations are independent of the action of the environment, directly due to its action, or to some extent dependent upon it. There are probably perhaps several possibilities. The germ-cells, for instance, are in many cases so sheltered from the action of surroundings that some of their variations may well be inherent. It is also well-nigh certain that there is such a thing as environmental variation. But here there are two possibilities. The action of the surroundings may directly set up variations, or it may simply act in such a way as to favour variational possibilities, *i.e.* it may direct and further, but not absolutely initiate. Nor is its action necessarily limited to either alternative.

HEREDITY

In cases of egg-development it is necessarily the germ-cells that are the means of transmitting characters from one generation to the next. Innumerable investigations upon such cells

also render it practically certain that the part concerned with heredity is the *nucleus*, *i.e.* the specialized particle of protoplasm which every germ-cell contains. Weismann limits the field still further, and considers that the nucleus is in part composed of "germ plasma", a protoplasmic material specially concerned with the transmission of characters. In typical egg-propagation (see vol. iii, p. 335) germ-cells from the two parents fuse together, and the essential point about the process seems to be the union of the two nuclei. This has undoubtedly an important bearing on the question of heredity, but precisely what bearing is still a matter of doubt. It is perhaps the most remarkable fact in the whole realm of knowledge that the fusion of two microscopic particles of protoplasm should carry with it so vast a range of possibilities as regards inheritance.

There are some clear cases which prove that the germ-cells are influenced by some of the factors in the surroundings. Yung, for example, by bringing up tadpoles on specially nutritious food, was able to produce with certainty an abnormal proportion of females (90 per cent or even more), and we have elsewhere seen (see p. 256) that a fertilized bee's egg may give rise to either a worker or queen, according to the nature of the food received by the larva. Even more remarkable is the case of certain lowly crustaceans upon which Schmankewitsch experimented. In the course of several generations he was able to convert a species (*Artemia Milhausenii*) living in saltish water into another species (*A. salina*), by gradually increasing the amount of salt. He also found it possible to conduct the experiment in the reverse order, and in this instance was able to go a step further, obtaining a third species of a distinct genus (*Branchipus stagnalis*), characteristic of perfectly fresh water. In the light of such facts it seems difficult to believe that there is no possibility of acquired somatic characters being transmissible, for we can scarcely maintain that in all the cases cited the germ-cells were directly influenced by modification in the surroundings.

Galton has formulated a law (since modified by Karl Pearson) expressing numerically the influence of parents and remoter ancestors upon the characters of offspring, and the application of mathematical methods to biological statistics is likely to yield important results in the immediate future, as regards heredity, variation, and many other problems. On the botanical side very

remarkable results bearing on the theory of heredity have been obtained by applying the principles of Mendel, but these cannot be discussed here, especially as there are difficulties in the way of conducting similar experiments on animals.

Readers who wish to acquire further knowledge in matters relating to biological theory would do well to consult the works of Darwin, Wallace (especially *Darwinism*), Romanes (*Darwin and After Darwin*), Weismann, Lloyd Morgan, Verworn (*General Physiology*), E. B. Wilson (*The Cell in Development and Inheritance*), T. Hunt Morgan (*Evolution and Adaptation*), and Mendel (*Principles of Heredity*). A good preliminary acquaintance with the subject may be obtained by reading Arthur Thomson's *Science of Life*.

GLOSSARY

Abomasum, in the stomach of Ruminants, the fourth compartment (chemical stomach).

Abysmal zone (Gk. *abyssŏs*, very deep), the deepest part of the sea.

Accommodation, adjustment of the individual to its surroundings.

Acetabulum (L. for vinegar cup), the socket in the hip into which the thigh-bone fits.

Acquired character, a character acquired by an individual in relation to its surroundings.

Adaptation, the adjustment of species to their surroundings.

Adductor muscles (L. *adduco*, I lead to), muscles which by their contraction close the shells of Bivalve Molluscs, Lamp-Shells, and Mussel-Shrimps.

Adipose fin, the small, fatty second dorsal fin of members of the Salmon Family.

Æsthetic or **Æsthetics** (Gk. *aisthētikŏs*, sensitive), the philosophy of the beautiful.

Afferent branchial vessels (L. *affĕrō*, I carry to; Gk. *branchia*, gills), blood-vessels which carry impure blood to gills to be purified.

Afferent nerve-fibre (L. *affĕrō*, I carry to), a nerve-fibre in which the impulse travels towards the central organs.

Air-bladder. See *Swim-bladder.*

Ala spuria. See *Bastard-wing.*

Albinism (L. *albus*, white or pale), exceptional whiteness or paleness in hue of some members of a species.

Albino, an individual exhibiting albinism.

Albumen, or **Albumin**, the complex albuminoid (which see) of which the white of an egg is made up.

Albuminoids, complex compounds, chiefly made up of carbon, hydrogen, oxygen, sulphur, and (in some cases) phosphorus.

Alima, pl. **-æ**, in Mantis-Shrimps, an attenuated kind of larva.

Ambergris, concretions formed in the intestine of the sperm-whale. Used in perfumery.

Ambulacral, relating to an ambulacrum; Ambulacral area, a band or zone bearing tube-feet; Ambulacral ossicle, one of the calcareous plates roofing an ambulacrum.

Ambulacrum, pl. **-a** (L. for pleasure grove), in Star-Fishes, one of the grooves in which the tube-feet are lodged.

Ammocætes, the larva of a Lamprey.

Amœboid movement, irregular flowing or creeping movements, performed by naked masses of protoplasm, *e.g.* in the Proteus Animalcule (Amœba).

Amphibious (Gk. *amphi*, both ways; *biŏs*, life): (1) able to breathe both ordinary air and air dissolved in water; (2) breathing dissolved air during the early part of life and ordinary air afterwards.

Ampulla (L. *ampulla*, a flask): (1) in the internal ear of Vertebrates, the swollen part of a semicircular canal; (2) in Echinoderms, a small sac connected with a tube-foot.

Anabolic, relating to anabolism.

Anabolism (Gk. *anabŏlē*, an ascent), the up-building chemical processes that take place within the body.

Analogous, displaying analogy.

Analogy (Gk. *analŏgŏs*, in agreement with), applied to parts which do the same physiological work irrespective of relative position and mode of development. See also *Homology.*

Anatomy (Gk. *anatomē*, dissection), the study of structure.

Anbury, in turnips, a disease due to the presence of a fungus-animal (*Plasmodiophora brassicæ*).

Antenna (L. for yard-arm): (1) one of the feelers of an Insect, or Myriapod; (2) one of the second feelers of a Crustacean; (3) one of the head-feelers of a Bristle-Worm.

Antennary gland, in higher Crustaceans, one of a pair of excretory organs by which nitrogenous waste is removed from the body. They open at the bases of the antennæ.

Antennule, in Crustaceans, one of the small first pair of feelers.

Anthrax, in cattle, &c., a bacterial disease, often set up by insect bites.

Anthropoid (Gk. *anthrōpŏs*, man; *eidŏs*, appearance), man-like.

Anti-toxin (Gk. *anti*, against; L. *toxicum*, poison), a complex organic substance (defensive proteid) conferring immunity against disease-germs.

Antler, in Deer, a bony outgrowth from the skull, which is shed annually.

Antler-royal, the third branch of a Red Deer's antler (counting from its base).

Aorta (Gk. *aeirō*, I carry), the chief artery of the body.

Aortic arches, the arteries which traverse the visceral arches of Vertebrates.

Apical disc, in Echinoderms (especially sea-urchins), a double circlet of plates on the upper surface of the body.

Apiculture (L. *apis*, a bee), bee-culture.

Apteria (Gk. *a*, without; *pterylŏn* a feather), featherless patches of a Bird's skin.

Arch, of a vertebra (or joint of the backbone), the dorsal part which forms the roof and sides of the hole traversed by the spinal cord.

Archenteron (Gk. *archē*, a beginning; *enteron*, an intestine), the digestive cavity of the Gastrula (which see).

Area of distribution, area inhabited by a species or other animal group. It is *discontinuous* if consisting of two or more isolated portions.

Artery, a blood-vessel which carries blood from the heart.

Articular processes, projections on the arches of vertebræ, by which these are connected together.

Artificial selection, the production of breeds of domesticated animals by human agency.

Assimilation (L. *adsimilo*, I make like), the conversion of digested food into body-substance.

Atavism (L. *atavus*, an ancestor). See *Reversion.*

Atlas, the ring-shaped first vertebra of the neck-region.

Atoll, a ring-shaped coral island.

Atrial cavity (L. *atrium*, a hall), a space surrounding most of the pharynx in Lancelets and Ascidians.

Atriopore, the opening of the Atrial cavity (which see).

Auricle (L. *auricula*, a little ear), a relatively thin-walled heart-chamber, into which veins pour blood.

Auricularia, pl. **-æ** (L. for lobe of the ear), in Sea-Cucumbers, a bilateral larva, provided with a sinuous ciliated band, suggesting the appearance of an ear in side-view.

Australian region, Australia and adjacent islands, with eastern part of East Indies, New Zealand, and Polynesia.

Axis, the second neck-vertebra.

Balancers (halteres), small club-shaped structures representing the reduced hind-wings in Flies.

Baleen ("whalebone"), in toothless Whales, elastic plates hanging down from the roof of the mouth.

Barb, one of the flattened branches borne by the axis of a feather.

Barbel, one of the sensitive filaments with which the mouth-region is provided in some Fishes, *e.g.* Cat-Fishes.

Barbule, one of the small branches borne by the barbs of a feather.

Bastard-wing (ala spuria), a tuft of feathers borne by the thumb of a bird.

Bêche-de-mer, Trepang (which see).

Bedeguar, a tufted gall on the rose, produced by the attack of a Gall-Fly.

Beneficials, those wild animals that by their habits promote the welfare of mankind.

Benthos (Gk. *bĕnthŏs*, depth), the assemblage of animals inhabiting deep water.

Bez-tine, the second branch of a Red Deer's antler (counting from its base).

Biconcave, hollow on both sides, *e.g.* the vertebra of a Fish.

Bicuspid. See *Premolar.*

Bilateral Symmetry. See *Symmetry.*

Bile, or **Gall**, the secretion of the liver.

Bile-duct, a tube through which bile passes into the intestine.

Biology (Gk. *biŏs*, life; *lŏgŏs*, a discourse), the science of life.

Bipinnaria, pl. **-æ**, in Star-Fishes, the bilateral larva, which is provided with pairs of soft ciliated arms.

Bivalve, applied to the shell of a Mollusc when made up of two pieces or valves, *e.g.* in a Mussel. Lamp-shells (Brachiopoda) are also bivalve, and Mussel-Shrimps (Ostracoda) possess a bivalve shield or shell.

Blastopore (Gk. *blastŏs*, a germ; *pŏra*, a passage), the mouth of a Gastrula (which see).

Blastosphere (Gk. *blastŏs*, a germ; *sphaira*, a sphere), a hollow and spheroidal kind of Blastula (which see).

Blastula (Gk. dim. of *blastŏs*, a germ), the embryonic stage resulting from Cleavage (which see).

Blight, a disease of plants, often due to the presence of aphides.

Blubber, in marine Mammals, a thick layer of fat below the skin.

Body-cavity, in animals higher than Zoophytes, a space or series of spaces between the internal organs and body-wall.

Botany (Gk. *botanē*, a plant), the science dealing with plants.

Bouchot, in mussel-culture, a collector made of stakes with interwoven twigs.

Brachiolaria, pl. **-æ**, a variety of the Bipinnaria (which see).

Bronchus, pl. **-i**, one of the two main branches of the wind-pipe.

Brood-parasitism, used of animals (*e.g.* the Cuckoo) which evade the responsibility of bringing up their own young.

Brow-tine, the lowest branch of a Red Deer's antler, projecting over the forehead.

Byssus (Gk. *byssos*), adhesive threads by which some Bivalve Molluscs attach themselves.

Cæcum, pl. **-a** (L. *cæcus*, blind), a blindly ending tube.

Calcaneum (L. for heel), the heel-bone.

Calcar (L. for spur), a small pointed projection on the inner side of a Frog's hind-foot.

Calcareous (L. *calx*, *calcis*, lime), of a limy nature.

Callosity, a hardened patch of skin.

Calyx (Gk. *kalyx*, a cup), the outer investing leaves of a flower.

Canine, one of the four "eye-teeth" in a Mammal. Situated outside the Incisors (which see), and well developed in carnivorous forms.

Cannon-bone: (1) in Horse, &c., the large metacarpal or metatarsal of the single digit; (2) in Ruminants, the compound bone formed by fusion of third and fourth metacarpals or metatarsals.

Capillaries (L. *capillus*, hair), microscopic blood-vessels with exceedingly thin walls. The name is misleading, since they are much smaller than the finest hairs.

Carapace, a firm protective shield covering the upper side and flanks in some animals.

Cardia (the Greek name), the opening between gullet and stomach.

Cardo (L. for hinge), the basal joint of an Insect's second jaw.

Carinate (L. *carina*, a keel): (1) with a keel-like projection; (2) applied to flying birds, in which the breast-bone possesses such a projection, for the attachment of the muscles of flight.

Carnassials (L. *carnosus*, relating to flesh), or **Flesh-teeth**, in Carnivores, four cutting cheek-teeth which act like scissors.

Carnivorous, flesh-eating.

Carotid (Gk. *kŏrā*, the head), a term applied to arteries which carry blood to the head and neck.

Carpale, pl. **-ia** (Gk. *karpŏs*, the wrist), the distal elements of the carpus.

Carpel (Gk. *karpŏs*, fruit), a modified flower-leaf that bears ovules. The Pistil (which see) consists of one or more carpels.

Carpus (Gk. *karpŏs*, the wrist), the skeleton of the wrist.

Cartilage, gristle.

Caste, in social Insects, a set of similar individuals.

Caval veins, in air-breathing Vertebrates, the great veins which return impure blood to the heart.

Caviare, the preserved hard roes (ovaries) of the sturgeon.

Cell, a nucleated mass of protoplasm, generally microscopic, and usually regarded as the unit of structure.

Centrale, a central element of the carpus or tarsus.

Centrum, pl. **-a**, of a vertebra, the relatively massive ventral part, flooring the hole traversed by the spinal cord.

Cephalo-thorax (Gk. *kĕphalē*, the head; *thōrax*, the chest), in some Arthropods, the front region of the body, formed by fusion of the head with part or all of the thorax.

Cerata (Gk. *kĕrata*, horns), in Sea-slugs (Nudibranchs), club-shaped outgrowths springing from the back.

Cercaria, pl. **-æ** (Gk. *kĕrkŏs*, a tail), in Flukes, a tadpole-shaped stage in the life-history. Produced by the Redia (which see), and immediately preceding the adult stage.

Cerci (Gk. *kĕrkŏs*, a tail), jointed rods projecting from the hinder end of an Insect's abdomen.

Cere (L. *cera*, wax), a bare patch of skin at the base of a Bird's beak.

Cerebellum (L. dim. of *cerebrum*, the brain), an unpaired dorsal outgrowth from the hinder part of the brain of a Vertebrate.

Cerebral hemispheres (L. *cerebrum*, the brain), the highest part of the brain in Vertebrates, usually consisting of a pair of outgrowths from near its front end.

Cervical (L. *cervix*, the neck), relating to the neck.

Chalaza (Gk. for hail), in a Bird's egg, a twisted cord-like structure traversing the albumen ("white") at either end.

Cheek-teeth, the back-teeth.

Chelicera, pl. **-æ**, (Gk. *chēlē*, a claw; *kĕras*, a horn), one of the first pair of head-limbs in Spider-like animals (Arachnida).

Chlorophyll (Gk. *chlōrŏs*, grass green; *phyllŏn*, a leaf), or **Leaf-green**, the characteristic pigment of green plants. It also occurs in a few lower animals.

Chordotonal organ (Gk. *chŏrdē*, a string; *tonaios*, stretched), in some Insects, a kind of sense-organ related to balance, or hearing, or both.

Choroid (Gk. *chŏriŏn*, skin; *eidŏs*, appearance), the middle coat of the eyeball. It is pigmented and vascular, and externally forms the iris (which see).

Chromatophore (Gk. *chrōma*, colouring matter; *phĕrō*, I bear), a small or minute body containing pigment, and situated in the skin. Colour-changes are due to the alteration in size of such bodies.

Chrysalis, pl. **-ides** (the Greek name), the pupa of a Moth or Butterfly.

Ciliary action, the movement of cilia.

Cilium, pl. cilia (L. *cilium*, eyelash), a microscopic thread of protoplasm, possessing the power of alternately bending and straightening. Numerous cilia are usually associated together. The derivation is misleading.

Circulatory organs, the structures concerned with distributing blood and lymph throughout the body.

Cirrus, pl. **-i** (L. *cirrus*, a tentacle): (1) one of the slender-jointed appendages of a Barnacle; (2) one of the sensory filaments borne by the segments of Bristle-Worms; (3) in Sea-Lilies, one of the jointed threads of which numerous circlets are borne by the stalk.

Claire, in French oyster culture, a muddy salt pond in which oysters are 'greened' by feeding on minute algæ.

Clavicle, the collar-bone.

Cleavage, the early divisions of the fertilized egg-cell, resulting in a Blastula (which see).

Clitellum (L. *clitellæ*, a pack-saddle), in Earth-Worms and Leeches, a glandular region of the skin, which secretes the material for the cocoon.

Cloaca (L. *cloaca*, a sewer), a chamber into which, *e.g.* in a Frog, intestine, excretory organs, and reproductive organs open.

Coccyx (Gk. for cuckoo), the reduced tail-region of the backbone in Man and the man-like Apes.

Cochineal, a red pigment extracted from the dried bodies of Cochineal Insects.

Cochlea (L. *cochlea*, a snail-shell), in Mammals, a spirally-coiled part of the membranous labyrinth.

Cocoon, a variously shaped case in which the eggs or other inactive stages in the life-history of various animals are enclosed.

Cœlom (Gk. *koilŏs*, hollow), a Body-cavity (which see) containing lymph-like fluid and communicating with the exterior by excretory tubes.

Cœnosarc (Gk. *koinŏs*, common; *sarx*, *sarcos*, flesh), in colonial Zoophytes, the common body by which the individuals are united.

Collar-cell, in Sponges, a cell bearing a single flagellum with a collar-like projection at its base.

Collector, in oyster- and mussel-culture, an arrangement of twigs, boards, or tiles, to which the larvæ or fry attach themselves.

Colonial, relating to a Colony (which see).

Colony, an assemblage of lower animals, in which the bodies of all the individuals are continuous. The condition is a result of vegetative propagation.

Columella (L. *columella*, a little pillar), a small rod which stretches across the drum of the ear in Birds, some Reptiles, and some Amphibians.

Columnar epithelium, epithelium composed of cells elongated at right angles to the surface.

Commensalism (L. *con-*, together; *mensa*, a dining-table), the association of two organisms as messmates, or commensals, to the benefit of one or both.

Compound eye, an eye made up of more or less numerous optically distinct elements each with an external facet. Possessed by many Arthropods.

Concha (L. *concha*, a shell) the ear-flap of a Mammal.

Condyle (Gk. *condylos*, a tubercle), a rounded projection on a bone or cartilage, where it helps to form a movable joint. Mandibular condyles, at back of lower jaw, where it unites with skull. Occipital condyle (or condyles), on back of skull, where it joins the backbone.

Conjugation (L. *conjugato*, *conjugatum*, to bind together), in some Animalcules, the temporary or permanent fusion of two individuals, accompanied by union of nuclear material, and having an invigorating effect, shown by active vegetative propagation.

Continental island, an island that was at one time part of an existing continent.

Contractile, endowed with contractility.

Contractility, the power possessed by protoplasm of changing its shape with no or slight change in volume.

Coracoid bone (Gk. *kŏrax*, a raven), a ventral element in the shoulder-skeleton of lower Vertebrates. Coracoid process, a projection (compared in Man to a raven's beak) on the shoulder-blade of Mammals, equivalent to the coracoid bone.

Cornea (L. *corneus*, horny), a transparent area of the sclerotic coat through which light enters the eye.

Corolla (L. for little crown), the inner investing leaves of a flower. Usually brightly coloured.

Corpus callosum (L. for hard body), a band of nerve-fibres which in most Mammals connects the cerebral hemispheres.

Corpuscles (L. dim. of *corpus*, a body), microscopic bodies floating in blood or lymph. White or Colourless Corpuscles, nucleated cells, able to change their shape, found in both blood and lymph. Red Corpuscles, round or oval discs present in the blood of many animals.

Cortex (L. *cortex*, bark), the external layer of the cerebral hemispheres and cerebellum.

Costal (L. *costa*, a rib), relating to the ribs.

Courtship coloration, beautiful colours displayed (usually by the male) as a courtship accessory.

Courtship selection, preferential mating, as determined by combat, or by the possession of æsthetic characters.

Cranial flexure, a bend in the brain.

Cranial nerves, the nerves which arise from the brain.

Cranium (Gk. *krāniŏn*, the skull), the brain-case.

Crop, in the gut of various animals, a dilated part of the gullet, or enlarged region following the gullet. It serves for temporary storage of food.

Cross-fertilization, fertilization of an egg-cell by a sperm (or its equivalent) derived from another organism.

Cross-pollination, transfer of pollen from the stamens of one flower to the stigma of another flower.

Coxa (L. *coxa*, a hip), the basal joint of an Insect's leg.

Cul de mulet, Sea-anemones used as an article of food in parts of southern Europe.

Cultch, in oyster-culture, empty shells, broken tiles, &c., upon which oysters are grown.

Cuticle, an elastic exoskeleton of horny consistency external to the epidermis, by which it is secreted.

Cysticercus, pl. -i (Gk. *cystis*, a bladder; *kĕrkŏs*, a tail), in most Tape-Worms, the bladder-worm stage.

Darwinism. See *Natural selection.*

Degeneration, a process of simplification whereby some forms adapt themselves to a parasitic or to a fixed mode of life.

Denitrifying, used of bacteria which liberate nitrogen from organic matter.

Dental formula, a numerical expression, showing the number and kinds of teeth present in a given species of Mammal.

Dentine (L. *dens*, *dentis*, a tooth), a hard substance of which teeth are chiefly composed.

Dermatoptic vision (Gk. *dĕrma*, *-atŏs*, a skin; *optikŏs*, pertaining to sight), seeing by means of the skin.

Dermis (Gk. *dĕrma*, a skin), the inner layer of the skin.

Diaphragm (the Greek name), the midriff.

Didactyle (Gk. *di-*, two; *daktylŏs*, a finger or toe), possessing two digits.

Digitigrade (L. *digitus*, the toe of an animal; *grado*, I walk), walking upon the digits.

Diphycercal (Gk. *diphyēs*, double; *kĕrkŏs*, a tail). See *Protocercal.*

Diploblastic (Gk. *diplous*, double; *blastŏs*, a germ), applied to animals in which the body is essentially composed of two cellular layers.

Dispersal, the spreading of a species from the area where it was first evolved.

Dorsal (L. *dorsum*, the back), applied to the upper side of an animal.

Ductless glands, a name applied to a number of small structures, of various use, which do not possess ducts or tubes for carrying off a liquid secretion. See *Lymphatic glands*, *Thymus*, *Thyroid*, *Spleen.*

Ectoderm (Gk. *ĕktŏs*, outside; *dĕrma*, a skin), the external cellular layer of the body.

Ectoparasite. See *Parasite.*

Eder-fold, one of the nesting-grounds of the eider-duck.

Efferent branchial vessels (L. *effĕrō*, I carry from; Gk. *branchia*, gills), blood-vessels which carry off purified blood from gills.

Efferent nerve-fibre (L. *effĕrō*, I carry from), a nerve-fibre in which the impulse travels outwards from the central organs.

Élevage, in French oyster-culture, the rearing of young oysters to a marketable size.

Éleveur, a French oyster-culturalist concerned with élevage.

Elytron, pl. -a, (Greek name for (1)): (1) in Insects, a fore-wing modified into a hard cover for the delicate hind-wing; (2) in some marine Bristle-Worms, a breathing-scale.

Embryology (Gk. *ĕmbryŏn*, an embryo; *lŏgŏs*, a discourse), the study of the development of animals.

Endoderm (Gk. *ĕndŏn*, within; *dĕrmă*, a skin), the internal cellular layer of the body.

Endoparasite. See *Parasite.*

Endoskeleton, internal hard parts serving for support, &c.

Entomophilous (Gk. *ĕntŏmŏs*, an insect; *phileō*, I love), of flowers, pollinated by insects.

Environment, the sum total of an animal's surroundings.

Eozoic epoch (Gk. *eos*, dawn; *zoē*, life), the most ancient geological era.

Ephippium (Gk. *ĕphippiŏn*, a saddle-cloth), in Water-"Fleas", a saddle-shaped thickening of the parent-shell, serving to enclose and protect the winter-eggs.

Ephyra, pl. -æ, a young jelly-fish of flattened form, produced by transverse fission of a fixed Zoophyte.

Epidermis (the Greek name), the protective outer layer of the skin.

Epigenesis (Gk. *ĕpi*, after; *gennaŏ*, I produce), the accepted view that development of animals is a process involving a gradual up-building from simple to complex. See *Preformation.*

Epiglottis (the Greek name), in Mammals, an elastic flap which prevents food from entering the wind-pipe.

Epipodium, pl. -ia (Gk. *epi*, upon; *pous*, *pŏdŏs*, a foot), in some Molluscs, a muscular flap arising high up either side of the foot.

Epipubic, connected with the front end of the Pubis (which see).

Epithelium, pl. -a, layers of cells covering external and lining internal surfaces.

Ethiopian region, south Arabia with Africa south of the Sahara.

Euglenoid movement, a wriggling mode of creeping effected by altering the shape of the body, as in Euglena, a sort of Animalcule.

Eustachian tube, a passage connecting the drum of the ear with the pharynx in air-breathing Vertebrates.

Evolution (L. *evolutio*, an unfolding), the development of species by modification of pre-existing species. See also *Special creation.*

Excretion, the getting rid of waste products.

Exhalent. See *Siphon.*

Exoskeleton, external hard parts serving for support, &c.

Extensor, applied to muscles which straighten or extend a limb, or region of the body.

Fascine, in oyster-culture, a bundle of twigs used as a spat-collector.

Femoral, relating to the thigh.

Femur (L. for thigh): (1) the thigh-bone of Vertebrates; (2) a part of the leg in Insects, &c.

Fenestra ovalis (L. for oval window), in Vertebrates, a membrane-filled vacuity in the

outer wall of the firm capsule containing the essential organs of hearing.

Fertilization, the fusion of two nuclear masses, commonly derived from different individuals.

Fetlock, in limbs of Horse, &c.: (1) the knuckle-joint of the single digit; (2) the tuft of hair attached to this joint.

Fibula (L. for bodkin), the bone of the lower leg which is on the little-toe side.

Fibulare, a proximal element of the tarsus, situated on the side next the little toe.

Filoplume, a small and imperfect feather, of downy texture.

Finger-and-Toe. See *Anbury*.

Fin-rays, in Fishes, skeletal rods which support the fins.

Fins, in various aquatic animals, flat expansions of the body used in swimming.

Fission (L. *findo*, *fissum*, to split), vegetative propagation by splitting of the parent body.

Flagellum, pl. **-a** (L. for whip-lash), an elongated thread of protoplasm, capable of executing lashing movements. A single cell bears but one or a few. See *Cilium*.

Flexor, applied to muscles which bend or flex a limb, or region of the body.

Fluke, in Cetaceans, one of the tail-lobes.

Fly-sickness, a fatal disease of horses, &c., set up by the attacks of the tsetse-fly.

Food-vacuole, in Animalcules, a food-containing space within the body.

Food-yolk, nutritive material stored up in (or outside) the egg-cell, for use during development.

Foot: (1) in broad sense, the extremity of any limb used for locomotion; (2) more strictly, the extremity of a hind-limb in Vertebrates; (3) an unpaired muscular projection from the under side of a Mollusc, used in locomotion.

Foot-stump. See *Parapod*.

Foramen, pl. -ina (L. for hole), a hole through which (usually) a nerve or blood-vessel passes. Foramen magnum, the large opening in the back of the brain-case, where brain and spinal cord are continuous.

Foramina repugnatoria, in Millipedes, small pores on the sides of the body, by which the stink-glands open.

Fore-gut, the front part of the digestive tube, developed as an inpushing from the exterior.

Fossils (L. *fossilis*, dug out), the remains of organisms, or proofs of their existence, which have been naturally imbedded in rocks.

Frenulum (L. dim. of *frenum*, a bridle), in Moths, one or more bristles projecting from the front of the hind-wing, and attaching this to the fore-wing by interlocking with the Retinaculum (which see).

Funicle (L. *funiculus*, a cord), in Moss-Polypes, a fibrous band connecting the stomach with the body-wall.

Funnel, a muscular tube through which Cuttle-fishes, &c., eject water from the gill-cavity, and are enabled to swim.

Furcula (L. for a prop), the "merry-thought" of a Bird, consisting of the two collar-bones united together.

Galea (L. for a helmet), in Insects, the outer branch of the second or third jaw.

Gall: (1) bile; (2) an abnormal external growth resulting from the attack of a parasite.

Gall-bladder, a membranous bag in which bile is temporarily stored.

Ganglion, pl. **ganglia** (Gk. for a small tumour), an aggregation of nerve-cells.

Ganglion-cell. See *Nerve-cell*.

Ganoid (Gk. *ganos*, brilliancy; *eidos*, appearance), applied to the regularly arranged bony plates (ganoid scales) covering the bodies of some Fishes.

Gapes, in Birds, a disease due to the presence of parasitic worms (*Syngamus trachealis*) in the air-passages.

Gastric glands, minute tubes imbedded in the lining of the stomach, and secreting gastric juice.

Gastric juice, a digestive fluid secreted or elaborated by the gastric glands. It acts on albuminoids, converting them into soluble diffusible peptones.

Gastric mill, in Crustaceans, a chewing apparatus with which the stomach is provided.

Gastrula (L. dim. from *gaster*, a stomach), a double-layered embryo possessing mouth and digestive cavity (archenteron).

Gemmation (L. *gemma*, a bud), production of new individuals by budding.

General aggressive resemblance, applied to predaceous forms which harmonize in appearance with their surroundings, and are thus rendered inconspicuous.

Genus, pl. **genera** (L. for a race or family), a classificatory group including one or more species.

Germinal disc, that part of the egg which, *e.g.* in a Bird, develops into the embryo.

Germinal variation, variation of germ-cells (ova and sperms).

Germ Plasma, that part of the nucleus of a germ-cell concerned (according to Weismann) with heredity.

Gill arches and clefts, in Fishes, &c., those visceral arches and clefts (which see) related to the gills.

Gill-cover, or **Operculum**, (pl. **-a**), in many Fishes, &c., a flap which covers the gill-slits.

Gill-rakers, in some Fishes, filaments projecting from the edges of the inner openings of the gill-pouches, and serving as a straining-apparatus.

Gizzard, in various animals, a thick-walled part of the digestive tube in which food is broken up.

Glenoid cavity (Gk. *glēnē*, a shallow socket), the socket into which the bone of the upper arm fits.

Glochidium, pl. **-a**, the larva of a Freshwater Mussel.

Glottis (the Greek name), the opening of the windpipe in the floor of the pharynx.

Gonophore (Gk. *gŏnŏs*, offspring; *phĕrō*, I bear), in Zoophytes, a bud in which egg-cells or sperms are produced.

Green glands. See *Antennary gland.*

Grey matter, that part of the central nervous system made up largely of nerve-cells.

Ground-Pearl, in some Scale-Insects, the encysted underground pupa.

Gular (L. *gula*, the throat), near the throat.

Gut, the digestive tube or alimentary canal.

Hæmoglobin (Gk. *haima*, blood; *globin*, a kind of albuminoid), a complex substance to which red corpuscles owe their colour, and which in some animals may be dissolved in the blood-plasma. Acts as an oxygen-carrier.

Halteres (L. for club-shaped weights used by gymnasts). See *Balancers.*

Haptic (Gk. *haptikŏs*, endowed with the sense of touch), used of sensations of contact.

Herbivorous, plant-eating.

Heredity, the transmission of characters from one generation to another.

Heterocercal (Gk. *hĕtĕros*, diverse; *kĕrkŏs*, tail), unsymmetrical. Used of the tail-fin of certain Fishes, *e.g.* Sharks.

Heterodactylous (Gk. *hĕtĕrŏs*, different; *daktylŏs*, a toe), in the feet of some climbing Birds, with the first and second toes turned back, while the third and fourth are directed forwards.

Hind-gut, the hinder part of the digestive tube, developed as an inpushing from the exterior.

Hip-girdle, the skeleton of the hip-region.

Histology (Gk. *histŏs*, a texture; *lŏgŏs*, a discourse), or **Minute anatomy**, the study of structure by means of the compound microscope.

Hock, in hind-limb of Horse, &c., the ankle.

Holarctic (Gk. *hŏlŏs*, all; *arktŏs*, the north), native to the colder parts of the Northern Hemisphere.

Homocercal (Gk. *hŏmŏs*, like; *kĕrkŏs*, a tail), applied to the lobed and externally symmetrical tail of ordinary Fishes.

Homologous, displaying homology.

Homology (Gk. *hŏmŏlŏgŏs*, agreeing), applied to parts which resemble one another as regards relative position and mode of development, irrespective of use or function. Serial homology, agreement between structures forming a series, *e.g.* spinal nerves. See also *Analogy.*

Honey-comb stomach. See *Reticulum.*

Host, an organism on which a parasite preys. See *Parasitism.*

Humeral, related to the upper arm.

Humerus (the Latin name), the upper-arm bone.

Hybernation, the habit of passing into a torpid state during the cold or dry season.

Hybrid (L. *hybrida*, a cross-bred animal), a cross between two distinct species. Hybrids are usually sterile.

Hydroid Zoophytes, colonial Cœlenterates which in fixed stage superficially resemble sea-weeds.

Hyoid bone, supports root of tongue in higher Vertebrates.

Hyomandibular, related to the first two visceral arches (which see), respectively known as mandibular and hyoid.

Ilium, the dorsal element of the hip-girdle.

Imago, pl. **-ines** (L. for figure, portrait, or statue), in Insects, the adult stage.

Incisor, one of the front teeth of a Mammal. Next to these are the Canines. See *Canine.*

Inhalent. See *Siphon.*

Insertion of a muscle, the end attached to a relatively movable part.

Instinct, the power of performing complex actions, subserving adjustment to surroundings, independently of experience or instruction.

Integropalliate, in the shell of a Bivalve Mollusc, with continuous pallial line.

Intelligence, the ability to profit by experience in adjusting behaviour to changing surroundings.

Interambulacral area, in Echinoderms, a band or zone which does not bear tube-feet.

Inter-clavicle, a skeletal element situated between the clavicles in some animals.

Intermedium, a proximal median element in the carpus or tarsus.

Interradial, in radially symmetrical animals, relating to an interradius.

Interradius, in radially symmetrical animals, a region of the body coming between two of the radii.

Invertebrate, devoid of a backbone or its equivalent.

Iris (L. for rainbow), the coloured part of the eye, serving as a diaphragm external to the lens. Its opening is the pupil.

Ischium, the ventral and posterior element of the hip-girdle.

Isinglass, a fine kind of gelatine, prepared from the swim-bladders of fishes, especially sturgeons.

Joint-gill, in Crustaceans, a gill attached to the joint at the base of a limb.

Kainozoic epoch, (Gk. *kainŏs*, recent; *zoē*, life), the latest geological era.

Katabolic, relating to katabolism.

Katabolism (Gk. *katabolē*, a casting down),

the down-breaking chemical processes that take place within the body.

Knee, in fore-limb of Horse, &c., the wrist.

Kungu cake, an edible substance prepared on the shores of Lake Nyassa, by collecting and compressing the aquatic larvæ of Insects.

Labellum (L. for little lip), the large lower petal of an Orchid.

Labium (L. for a lip), the lower lip of an Insect, formed by the more or less complete fusion of the third jaws (second maxillæ).

Labrum (L. for lip), the upper lip of an Arthropod.

Laceration, in Sea-Anemones, production of new individuals by the separation of small fragments of the base.

Lacinia (L. for a small part), in Insects, the inner branch of the second or third jaw.

Lacteals (L. *lac*, milk), the lymphatics of the intestine, so called on account of the milky appearance of their contents (digested fat) after a meal.

Lagena (L. for earthen jar), a curved tubular part of the membranous labyrinth in Birds, &c., equivalent to the Cochlea (which see) of Mammals.

Land-bridge, a submerged area that once united two tracts of land now separated by the sea.

Larva, pl. **-æ** (L. *larva*, a kind of actor's mask), in many life-histories, an early free-living stage (*e.g.* a Tadpole or a Caterpillar) which is more or less unlike the adult.

Larynx (the Greek name), the voice-box.

Licked beef, diseased flesh in the neighbourhood of Warbles (which see).

Ligament: (1) a fibrous band running between two skeletal elements; (2) an elastic band (external ligament) or pad (internal ligament) by which the shell of a Bivalve Mollusc is opened.

Limb-gill, in Crustaceans, a gill attached to a limb.

Littoral (L. *litus*, *littoris*, a shore), belonging to the shore.

Liver-rot, in Sheep, &c., a disease caused by the presence of Liver-Flukes.

Lophophore (Gk. *lŏphŏs*, tuft or crest; *phĕrō*, I bear), in Moss-Polypes, the crown of tentacles.

Louping-ill, in Sheep, a bacterial disease caused by the attacks of Ticks.

Lung-books, in Scorpions and Spiders, breathing organs consisting of depressions into which numerous leaf-like folds project.

Luring, the attraction of farm-pests from the plants they attack.

Lymph, clear fluid containing colourless corpuscles.

Lymphatic glands, swellings in the course of lymphatics, in which new colourless corpuscles are developed.

Lymph-system, a series of spaces and tubes containing Lymph (which see).

Macronucleus (Gk. *makrŏs*, large), in Animalcules, the large nucleus.

Madreporite, in Echinoderms, a perforated calcareous plate, through which fluid enters the water-vascular system.

Maggot, in Insects, a limbless worm-shaped larva.

Malpighian tubes, in Insects, excretory tubes opening into the hinder part of the gut.

Mandible: (1) in Vertebrates, the lower jaw; (2) in Arthropods, one of the first pair of jaws.

Manna, a sweet substance (honey-dew) secreted by a species of Scale-insect.

Mantle, in Molluscs and Lamp-Shells, a flap of the body-wall, on the outer side of which shell-substance is formed.

Mantle-cavity, in Molluscs and Lamp-shells, a space between the body and Mantle (which see). It contains the gill or gills (in aquatic Molluscs), and the intestine, excretory organs, &c., usually open into it.

Manyplies. See *Omasum*.

Masking, inconspicuousness produced by a covering of foreign objects, *e.g.* stones and bits of sea-weed.

Mastax (Gk. for the mouth), the gizzard-like pharynx of Rotifers.

Maxilla, pl. **-æ** (L. *maxilla*, a jaw): (1) in Vertebrates, a bone of the jaw; (2) in Arthropods, one of the second or third pair of jaws.

Medusa, in Jelly-Fishes, the egg-producing stage, which is usually free-swimming.

Megalopa, pl. **-æ** (Gk. *megălŏpŏus*, having large feet), in Crabs, the larval stage succeeding the Zoæa. The legs are well-developed and the tail large.

Melanic, exhibiting melanism.

Melanism (Gk. *mĕlas*, *-anŏs*, dark), exceptional darkness in hue of some members of a species.

Membranous labyrinth, in Vertebrates, the complex bag constituting the essential part of the internal ear.

Mentum (L. for the chin), the part of an Insect's lower lip that succeeds the Submentum (which see).

Mesentery (Gk. *mĕsĕntĕriŏn*, same meaning as (1)): (1) in Vertebrates, a membrane by which the digestive tube is held in place; (2) in Bristle-Worms, one of the transverse partitions marking off the segments internally; (3) in Sea-Anemones, &c., one of the partitions connecting the gullet with the body-wall.

Mesoderm (Gk. *mĕsŏs*, middle; *dĕrma*, a skin), the middle cellular layer of the body.

Mesoglœa (Gk. *mĕsŏs*, middle; *glŏiŏs*, a jelly-like substance), in Zoophytes, the middle often jelly-like layer of the body.

Mesotarsal, in the middle of the tarsus, *e.g.* a Bird's ankle-joint.

Mesozoic epoch (Gk. *mesos*, middle; *zoē*, life), the latest geological era but one.

Metabolic, relating to metabolism.

Metabolism (Gk. *mĕtabolē*, change), the cycle of chemical changes taking place within the body.

Metacarpale, pl. **-ia**, one of the skeletal elements supporting the palm.

Metacarpus (Gk. *mĕtakarpiŏn*, the palm of the hand), skeleton of palm of hand.

Metamorphosis (Gk. for transformation), the series of changes by which the adult stage is attained, in cases where the young animal differs markedly from its parents. See *Larva*.

Metatarsale, pl. **-ia**, one of the skeletal elements supporting the instep.

Metatarsus (Gk. *mĕta*, after; *tarsŏs*, the broad part of the foot), the skeleton of the instep-region of the foot.

Micronucleus (Gk. *mikrŏs*, small), in Animalcules, the small nucleus.

Microtome (Gk. *mikrŏs*, small; *tĕmnŏ*, I cut), an instrument for cutting thin slices for microscopic examination.

Mid-gut, the middle section of the digestive tube.

Migration (L. *migratio*, removal from one home to another), the wandering of species from one place to another, often in a periodic manner. See also *Dispersal*.

Milk dentition, in Mammals, the first set of teeth.

Milk molar, in Mammals, one of the cheek-teeth of the milk dentition.

Mimicry, or **Spurious warning**, the resemblance existing between certain innocuous forms and others exhibiting Warning coloration, &c. (which see). The mimicking species share in the relative immunity enjoyed by the mimicked forms.

Miners' anæmia, a dangerous intestinal disease, caused by a palisade-worm (*Dochmius duodenalis*).

Molar, one of the permanent cheek-teeth of a Mammal, belonging to the hinder part of the series, and without a predecessor in the first set of teeth (milk teeth).

Mongrel, a cross between two varieties or races of the same species. Mongrels are usually fertile.

Morphology, (Gk. *mŏrphē*, form; *lŏgŏs*, a discourse), the study of form and structure.

Morula (L. dim. of *morum*, a mulberry), a solid and spherical variety of Blastula (which see).

Mucous membrane, the soft membrane lining the digestive tube.

Mule, a cross between Horse and Ass.

Muscle: (1) the tissue which makes up flesh; (2) a definitely-shaped piece of flesh, concerned with some special movement or movements.

Mutualism, or **Symbiosis**, the intimate association of two organisms as mutualists, for the benefit of both.

Myrmecophilous (Gk. *myrmēx*, *-ēkŏs*, an ant; *phileō*, I love), of certain plants, protected by ants, which in return receive food and shelter.

Nagana, Fly-sickness (which see).

Natural selection, the survival of individuals which vary in favourable directions in relation to their surroundings.

Nauplius (Gk. *Naupliŏs*, a son of Neptune), in lower Crustaceans, an ovoid unsegmented larva possessing only the three first pair of head-appendages, by means of which it swims.

Nearctic region (Gk. *nĕŏs*, new; *arktŏs*, the north), the northern part of the New World.

Nectar (Gk. *nĕktăr*, the drink of the gods), a sweet fluid produced by a nectary.

Nectary, in plants, an organ secreting nectar.

Neo-Lamarckism, a theory of evolution which postulates the existence of definite Laws of Growth.

Neolithic period (Gk. *nĕŏs*, new; *lithŏs*, a stone), the later stages of the Stone Age.

Neotropical region (Gk. *nĕŏs*, new; *trŏpikŏs*, relating to the tropics), Central and South America, with the West Indies.

Nephridium, pl. **-ia** (dim. of Gk. *nĕphrŏs*, a kidney), in many groups of animals, excretory tubes by which nitrogenous waste is removed from the body. They place the Cœlom (which see) in communication with the exterior.

Neritic zone (*nēritēs*, a sea-snail), the shallow waters of the sea.

Nerve-cell, the essential part of a Neuron (which see).

Nerve-fibre, the conducting thread into which a Neuron (which see) is produced.

Nerve-loop, in Molluscs, part of the central nervous system which gives off nerves to the gills and viscera.

Nerve-ring, in Annelids, Arthropods, Molluscs, &c., part of the central nervous system which surrounds the front portion of the gut.

Nervure, one of the linear thickenings supporting the wing of an Insect.

Nettling-cell, in Zoophytes (Cœlenterata), a stinging capsule.

Neural (Gk. *nĕurŏn*, a nerve), related to the central nervous system, or in the proximity of this.

Neuron (Gk. for a nerve), a nerve-unit, consisting of a nerve-cell with its prolongations.

Nictitating membrane, the translucent third eyelid of Birds, &c., which can be drawn over the eye as a protection.

Nidicolæ (L. *nidus*, a nest; *colo*, I inhabit), in Birds, helpless nestlings.

Nidifugæ (L. *nidus*, a nest; *fugio*, I run away), in Birds, young which run about and feed themselves almost immediately after hatching.

Nitrifying, used of bacteria, &c., which cause free nitrogen to enter into combination.

Notochord (Gk. *nŏtŏn*, the back; *chŏrdē*, a string), an elastic supporting-rod which

underlies the central nervous system of a Vertebrate embryo, and may persist throughout life. Usually more or less replaced by the backbone, of which it is the forerunner.

Nuchal (L. *nucha*, neck), relating to the neck.

Nucleus (L. for a kernel), a specialized particle of protoplasm within a cell.

Nymph, in Insects with incomplete metamorphosis, the stage which hatches from the egg.

Oceanic island, an island that has never formed part of any existing continent.

Ocellus, pl. -i, (L. for a little eye), in Arthropods, a small simple eye.

Ocular (L. *oculus*, an eye), bearing eyes, *e.g.* the ocular plates in the apical disc of a sea-urchin.

Odontophore (Gk. *ŏdous, ŏdŏntŏs*, a tooth; *phĕrō*, I bear), the rasping organ in the mouth-cavity of Snails, Cuttle-Fishes, &c.

Œsophagus, the gullet.

Omasum, in the stomach of Ruminants, the third compartment.

Omnivorous, of mixed diet.

Ontogeny (Gk. *ŏnta*, beings; *gĕnnaō*, I produce), the development of individual animals.

Operculum, pl. -a (L. for lid or cover): (1) the gill-cover of a Fish; (2) the horny or shelly plate with which the opening of the shell can be closed in some Sea-snails; (3) in Scorpions, King-Crabs, &c., a plate on the under side of the body, immediately behind the last pair of legs; (4) the plug with which some tube-dwelling Annelids can close the openings of their tubes.

Opisthobranch (Gk. *ŏpisthĕ*, behind; *branchia*, gills), applied to Sea-Snails with gills behind the heart.

Oral (L. *ōs*, the mouth), relating to the mouth.

Oral papillæ, in Peripatus, a pair of stump-like limbs near the mouth, upon which the slime-glands open.

Orbit, the cavity of the skull in which the eye-ball is lodged.

Organic selection, the co-operation of Accommodation and Adaptation (which see) in the production of new species.

Oriental region, south Asia, with the adjacent part of the East Indies, the Philippines, and Formosa.

Origin of a muscle, the end attached to a relatively fixed part.

Osculum (L. for a little mouth), in Sponges, an opening by which currents of water leave the body.

Osphradium, pl. -ia (dim. of Gk. *ŏsphra*, an odour), a sense-organ which probably tests the nature of the water entering the gill-cavity of aquatic Molluscs.

Ossicle (L. dim. of *ŏs*, a bone), a small irregular bone. Auditory ossicles, in drum of ear.

Otocyst (Gk. *ous, ōtŏs*, an ear; *cystis*, a bladder), a minute vesicle of sensory nature, containing one or more hard particles. Probably a balancing organ.

Otolith (Gk. *ous, ōtŏs*, an ear; *lithŏs*, a stone), a firm particle within an otocyst or internal auditory organ.

Ovary, an organ producing egg-cells.

Oviparous (L. *ovum*, an egg; *pario*, I produce), egg-laying.

Ovipositor, in Insects, a piercing arrangement at the hinder end of the body in the female, for making holes in plants, &c., and introducing eggs into them.

Ovule (L. dim. of *ovum*, an egg), in Flowering Plants, the small body which becomes a seed after the egg-cell it contains has been fertilized.

Ovum, pl. -a (L. for an egg), an egg-cell, the earliest stage in the development of an embryo.

Oyster-park, an enclosed area of shallow water in which oysters are grown.

Pacinian corpuscle, a minute ovoid laminated body, connected with a sensory nerve, and probably having to do with the pressure-sense.

Palæarctic region (Gk. *palaiŏs*, ancient; *arktŏs*, the north), the northern part of the old world.

Palæolithic period (Gk. *palaiŏs*, ancient; *lithŏs*, a stone), the earlier stages of the Stone Age.

Palæozoic epoch (Gk. *palaiŏs*, ancient; *zoē*, life), the most ancient geological era but one.

Pallial line, in Bivalve Molluscs, a mark on the inner side of each valve, corresponding to the attachment of the mantle or pallium.

Pallium (L. for a cloak). See *Mantle*.

Palmated (L. *palma*, a hand), divided like a hand.

Palp (L. *palpo*, I touch gently), a sensitive outgrowth, *e.g.* of some mouth-parts in Insects. Labial palp, one of four sensitive triangular flaps adjoining the mouth of a Bivalve Mollusc.

Pancreas (the Greek name), the sweet-bread. An abdominal gland, which pours its secretion (pancreatic juice) into the intestine.

Pancreatic juice, the secretion of the pancreas. It acts upon albuminoids, starch, and fats.

Papilla (L. for a nipple), a small projection.

Parapod, or **Parapodium**, pl. -ia (Gk. *para*, by the side of; *pous, pŏdŏs*, a foot): (1) in Bristle-Worms, one of the hollow conical unjointed foot-stumps; (2) in some Sea-Slugs, a muscular flap arising far down on each side of the foot.

Parasite (Gk. *parasītŏs*, a sycophant), an organism which lives on (ectoparasite) or in (endoparasite) a larger organism ("host"), feeding on its juices, substance, or digested food.

Parasitism (Gk. *parasītŏs*, a sycophant), the association of a parasite with a "host", the

former preying upon the latter by feeding on its blood, &c., or the food it has digested.

Parotid glands, the hindermost pair of salivary glands.

Patella (the Latin name), the knee-pan

Paunch. See *Rumen.*

Pearl, in Molluscs, a disease product, formed by deposit of calcareous layers round a foreign body, *e.g.* a dead parasite or a grain of sand. See also *Ground-Pearl.*

Pecten (L. for a comb), a vascular folded structure that projects into the eye of a Bird, behind the lens.

Pectines (L. for combs), in Scorpions, a pair of comb-shaped organs situated immediately behind the operculum (which see).

Pectoral (L. *pectus, pectoris*, the chest), applied to structures, *e.g.* the fore-limbs of a dog, connected with the chest or thorax.

Pectoralis major, the great muscle of the breast, by which the fore-limbs are drawn towards one another.

Pedicellaria, pl. **-æ** (dim. of L. *pedica*, a trap), in Star-Fishes and Sea-Urchins, a pincer-like spine.

Pedipalp, in Spider-like animals (Arachnida), one of the second pair of head-limbs.

Pelagic (Gk. *pĕlagikŏs*, marine), living in the open sea, at or near the surface.

Pelagic zone, the surface waters of the sea.

Pelvic, applied to structures, *e.g.* the hinder pair of fins in a shark, connected with the Pelvis (which see).

Pelvis (L. *pelvis*, a basin), applied to that part of the skeleton to which the hind-limbs are attached.

Pemmican, sun-dried meat.

Pentadactyle (Gk. *pĕntĕ*, five; *daktylŏs*, a finger or toe), possessing five digits.

Pepsin, an albumen-digesting ferment contained in gastric juice.

Peptic glands. See *Gastric glands.*

Peptone, a soluble and diffusible form of albuminoid. It is produced by the action of gastric juice and pancreatic juice upon the albuminous part of the food.

Pericardial, relating to the pericardium.

Pericardium (Gk. *peri*, around; *cardia*, the heart), the cavity in which the heart is contained.

Peristaltic (the Greek word), applied to the wave-like contractions of the intestines and (in lower forms) blood-vessels.

Permanent dentition, the second set of teeth in a Mammal.

Persistent type, an animal species or genus persisting for a long period of geological time, without obvious modification.

Petal (Gk. *pĕtalŏn*, a flower-leaf), one of the inner set (corolla) of investing flower-leaves.

Phagocyte (Gk. *phagein*, to eat; *cytŏs*, a small box, hence a cell), a colourless corpuscle.

Phalanges, sing. **Phalanx** (Gk. *phalanx*, a finger- or toe-bone), bones of fingers and toes.

Pharyngeal, relating to the Pharynx (which see).

Pharynx (the Greek name), that region of the digestive tube which follows the mouth-cavity.

Phylogeny (Gk. *phylŏn*, a tribe; *gĕnnaō*, I produce), the evolutionary history of animals.

Phylum, **-a** (Gk. *phylŏn*, a race or tribe), one of the main subdivisions of the animal kingdom, *e.g.* Vertebrata, Mollusca, Protozoa.

Physiological selection, the theory that the isolation necessary for the origin of new species is due to partial or complete sterility of varying forms with the parent stock.

Physiology (Gk. *physis*, nature; *lŏgŏs*, a discourse), the study of the uses or functions of the parts (organs) of plants and animals. It was formerly used in a much wider sense.

Pilidium, pl. **-a** (Gk. *pilidiŏn*, a little cap), in some Nemertine worms, a ciliated larva resembling a cap or helmet with rounded side-flaps.

Pineal body, a problematic structure connected with the roof of the brain in Vertebrates, and probably representing the remains of a Pineal eye (which see).

Pineal eye, an unpaired dorsal eye present in some Reptiles. See *Pineal body.*

Pinna, the ear-flap of a Mammal.

Pinnule (dim. of L. *pinna*, a feather), in Feather-stars, one of the small branches of the ten arms.

Pisciculture (L. *piscis*, a fish), the artificial culture of Fishes, *e.g.* carp in ponds.

Pisiform bone (L. *pisum*, a pea), a small rounded bone present in the carpus of some animals, external to the ulnare (which see).

Pistil (L. *pistillum*, pestle), the central part of a flower, in which seeds are produced.

Pituitary body, a problematic structure attached to the under side of the brain in a Vertebrate. Possibly the vestige of a sense organ (cp. *Pineal body*).

Placoid (Gk. *plakous*, a cake; *eidŏs*, appearance), used of the thick rounded bony scales of Sharks and Rays.

Placula (Gk. dim. of *plakous*, a flat cake), a plate-shaped Blastula (which see).

Plankton (Gk. *planktos*, wandering), the floating and drifting population of the sea and lakes.

Plantigrade (L. *planta*, the sole of the foot; *gradior*, I walk), walking upon the palms of the hands and soles of the feet.

Planula (L. dim. of *planus*, a vagrant), in Sponges and Zoophytes, an ovoid ciliated larva.

Plasma (Gk. *plasma*, that which has been formed), the fluid part of the blood and lymph. See also *Corpuscles.*

Plastron, (Fr. for a breastplate), the under part of the exoskeleton in a Tortoise or Turtle.

Ploughshare-bone: (1) in Birds, the bone which supports the tail-quills; (2) in the Mole, a flat curved bone on the inner side of the hand.

Pluteus, pl. -ei (L. for a roof made of hurdles), in Brittle-Stars and Sea-Urchins, the bilateral larva, which is provided with pairs of ciliated arms, and supported by an internal calcareous skeleton.

Pneumatic duct, in Fishes, a tube which (temporarily or permanently) connects the swim-bladder with the gullet.

Polar bodies, in the maturation of the egg-cell (ovum), two small cells resulting from the last two cell-divisions.

Pollen (L. for fine flour), in flowers, the fertilizing substance produced by the stamens, and consisting of minute pollen-grains.

Pollen-tube, a delicate tube growing from a pollen-grain, and effecting the fertilization of the egg-cell.

Pollination, in flowers, transfer of pollen to the stigma.

Pollinium, pl. -ia, an agglutinated mass of pollen.

Polype, in Zoophytes (Cœlenterata), an individual animal.

Portal veins, veins which carry impure blood to the liver (hepatic portal vein) or to the kidneys (renal portal veins).

Post-axial, behind the axis of a limb.

Posterior nares, the opening or openings by which in air-breathing Vertebrates the cavities of the nose open into the mouth-cavity or pharynx.

Pre-axial, in front of the axis of a limb.

Precoracoid, a skeletal element present in front of the coracoid in some animals.

Preformation, the obsolete theory that the development of an animal results from simple increase in size of parts already present in miniature.

Prehensile (L. *prehenso*, I seize), grasping.

Premolar, one of the permanent cheek-teeth of a Mammal, belonging to the front part of the series, and often preceded by a Milk molar (which see).

Primary, inherited from remote ancestors.

Proboscis (the Greek name), an elongated structure at the front end of certain animals, *e.g.* the trunk of an elephant or the sucking mouth-parts of a butterfly.

Process, a projecting part, *e.g.* of a bone.

Procœlous (Gk. *prŏ-*, in front; *koilŏs*, hollow), applied to vertebræ of which the bodies are concave in front and convex behind.

Producteur, a French oyster-culturalist concerned with production.

Production, in French oyster-culture, the collection and rearing of spat.

Proglottis, pl. -ides (Gk. *proglŏssis*, the tip of the tongue), in Tape-Worms, one of the egg-producing joints of the body.

Pro-legs, in Insect-larvæ, temporary sucker-like legs.

Pronation (L. *pronus*, prone), position of the fore-arm when back of hand is directed upwards.

Prosobranch (Gk. *prŏ-*, in front of; *branchia*, gills), applied to Sea-snails with gill or gills in front of the heart.

Prostomium (Gk. *prŏ-*, before; *stŏma*, a mouth), the head-lobe.

Proteids. See *Albuminoids*.

Protocercal (Gk. *prōtŏs*, first; *kĕrkŏs*, tail), applied to the symmetrical unlobed tail of some fishes.

Protoplasm (Gk. *prōtŏs*, first; *plasma*, that which has been formed), the complex substance which makes up the living part of the bodies of all organisms.

Proventriculus (Gk. *prŏ-*, in front of; L. *ventriculus*, the stomach), the first or chemical stomach of a Bird.

Proximal, at or near the attached end.

Psalter. See *Omasum*.

Pseudobranch (Gk. *pseudēs*, false; *branchia*, gills), a gill which has been reduced to a Vestige (which see).

Pseudopodium, pl. -ia (Gk. *pseudēs*, false; *pous*, *pŏdŏs*, a foot), in naked Animalcules, one of the blunt lobes which can be protruded by the protoplasm.

Psychology (Gk. *psychē*, the mind; *lŏgŏs*, a discourse), the study of mind.

Pteryla, pl. -æ (Gk. *pterŏn*, a plume), a feather-covered tract of skin.

Pubis, the ventral and anterior element of the hip-girdle.

Pulmonary (L. *pulmo*, a lung), relating to the lungs.

Pulvillus, pl. -i (L. *pulvillus*, a little pillow), in the feet of some Insects, an adhesive end-flap.

Pupa (L. for a doll), in Insects, a motionless stage in the life-history.

Pupil (L. *pupilla*, same meaning), the opening in the Iris (which see).

Pygal (Gk. *pygē*, the rump), related to the hinder part of the body.

Pyloric, applied to that end of the stomach which adjoins the intestine. See *Pylorus*.

Pylorus (Gk. *pylaōrŏs*, having charge of a gate), the opening between stomach and intestine.

Quadrate bone and Quadrate cartilage, a bone (or cartilage) by which the lower jaw is attached to the skull in most Vertebrates except Mammals.

Quarter-evil. See *Anthrax*.

Rachis (Gk. *rhachis*, the backbone), the axis of a feather.

Radial, in radially symmetrical animals, relating to a radius.

Radiale, a proximal element in the carpus, situated on the side next the thumb.

Radial symmetry. See *Symmetry.*

Radius: (1) (L. *radius*, a ray), in radially symmetrical animals, one of the axes of symmetry which radiate from a central point, as the spokes of a wheel do from the hub; (2) (the Latin meaning), the bone of the fore-arm which is on the thumb-side.

Radula (L. *radula*, a scraper), the horny tooth-studded ribbon that constitutes the rasping part of the Odontophore (which see).

Raphides (Gk. *rhaphis*, *-idŏs*, a needle), in plants, bundles of needle-shaped crystals of oxalate of lime.

Ratite (L. *rates*, a raft): (1) shaped like a raft, *i.e.* devoid of a keel-like projection; (2) applied to running birds, in which the breast-bone is so shaped.

Recapitulation, repetition of ancestral stages in the life-history.

Recognition-markings, in Birds and Mammals, colour-arrangements which aid in rapid recognition by members of the same species.

Rectrices (L. for female rulers), quill-feathers of the tail.

Redia, pl. **-æ** (after the Italian naturalist *Redi*), in Flukes, a cylindrical stage in the life-history, produced by the Sporocyst (which see).

Reed. See *Abomasum.*

Regeneration, the power of repairing injuries.

Rejuvenescence (L. *rejuvenesco*, I become young again), the invigoration produced by nuclear fusion. See *Fertilization.*

Remiges (L. for rowers), quill-feathers of the wing.

Rennet stomach. See *Abomasum.*

Rennin, a milk-curdling ferment contained in gastric juice.

Resemblance, General, a harmonizing with surroundings producing inconspicuousness. It may be protective, aggressive, or both. When capable of adjustment it is said to be *variable.*

Resemblance, Special, a resemblance to some specific object in the surroundings, by which inconspicuousness is produced. It may be protective, aggressive, or both. When capable of adjustment it is said to be *variable.*

Reticulum (L. for a little net), in the stomach of Ruminants, the second compartment.

Retina (L. *rete*, a net), the sensitive internal layer of the eye.

Retinaculum (L. for a rope or bond), in Moths, a tuft of scales or flap on the posterior part of the fore-wing. The Frenulum (which see) interlocks with it.

Retractile (L. *retractum*, drawn back), capable of being drawn back.

Reversion, the appearance of characters unlike those of the preceding generation, but resembling those of remoter ancestors.

Rhabdites (Gk. *rhabdŏs*, a rod), in Planarian Worms (Turbellaria), microscopic rods discharged from the skin as a means of defence and probably of irritant nature.

Rhopalion, pl. **-a** (Gk. *rhŏpalŏn*, a club), in some Jelly-fishes, a specialized club-shaped tentacle bearing various sense-organs.

Rods and Cones, the sensitive cells of the eye in Vertebrates.

Rostellum (L. for little beak), a sticky knob connected with the pollinia of an orchid.

Rudimentary organ. See *Vestige.*

Rumen (L. *ruminatio*, chewing the cud), in the stomach of Ruminants, the first compartment.

Rumination (L. *ruminatio*), chewing the cud.

Sacrum, in the backbone, the part connected with the supports (hip-girdles) of the hind-limbs.

Saliva (the Latin name), spittle.

Salivary gland, a gland which secretes or elaborates saliva (spittle).

Scaly epithelium, epithelium composed of flat cells.

Scapula (the Latin name), the shoulder-blade.

Sclerotic (Gk. *sklērŏs*, hard), the tough external coat of the eyeball.

Sebaceous (L. *sebum*, grease), of a greasy or oily nature.

Secondary: (1) acquired within the limits of a group; (2) replacing some earlier structure.

Segmentation: (1) the division of the adult body into successive rings, segments, or somites; (2) the early stages of division in the egg-cell.

Self-fertilization, fertilization of an egg-cell by a sperm (or its equivalent) derived from the same organism.

Self-pollination, transfer of pollen to the stigma of a flower from its own stamens.

Semi-plantigrade, with palms and soles partly resting on the ground.

Sepal (Gk. *skĕpē*, a covering), one of the outer set (calyx) of investing flower-leaves.

Sessile (L. *sessilis*, sitting), without a stalk.

Seta, pl. **-æ** (the Latin name), a bristle.

Shagreen, the skins of certain Sharks and Dog-Fishes, containing numerous hard scales.

Shell-cameos, carvings made on certain shells which are composed of differently coloured layers.

Shell-gland, in lower Crustaceans, one of a pair of excretory organs removing nitrogenous waste from the body. They open at the bases of the third jaws (2nd maxillæ).

Shell-muscle, the muscle by which a snail is attached to its shell.

Shoulder-girdle, skeleton of shoulder.

Side-gill, in Crustaceans, a gill attached to the side of the body.

Signalling coloration, conspicuous patches of colour, *e.g.* the white tail of a Rabbit, displayed during rapid movement. The ap-

proach of danger is thus communicated to other members of the community.

Simple epithelium, epithelium only one cell thick.

Sinupalliate (L. *sinus*, a bay), in Bivalve Molluscs, with a posterior indentation in the pallial line, caused by the attachment of a muscle for drawing back the siphons.

Siphon (L. *sipho*, a siphon), in aquatic Molluscs, a tubular prolongation of the mantle by which water enters (inhalent siphon) or leaves (exhalent siphon) the gill-chamber.

Siphuncle (L. *siphunculus*, a small pipe), in the Pearly Nautilus and many extinct Cephalopods, a sort of tube that runs through the chambers of the shell.

Society, an association of gregarious animals.

Soma (Gk. for body), the body of an animal exclusive of the germ-cells.

Somatic variation, variation of the soma (which see).

Spat, the free-swimming larvæ or fry of Oysters, Mussels, &c.

Special creation, applied to the almost obsolete view that all species or kinds of organism have been independently created. See *Evolution*.

Sperm (Gk. *spĕrma*, seed), a small and usually motile propagative cell, which fertilizes an egg-cell (ovum) by fusing with it.

Spermaceti, in the Sperm-Whale, liquid fat contained in a deep depression on the upper side of the skull.

Spermary, an organ producing sperms.

Spicule, (L. *spiculum*, a sharp point), in some Zoophytes (Cœlenterata), Sponges, and Animalcules (Protozoa), an element of the skeleton, of varied shape and chemical composition.

Spinal cord, or **Spinal marrow**, a cylindrical nerve-mass, constituting the hinder part of the central nervous system in a vertebrate animal.

Spinal nerve, a nerve taking origin in the spinal cord.

Spinnerets, in Spiders, small rounded projections on the under side of the abdomen, on which the silk glands open.

Spiracle, (L. *spīro*, I breathe): (1) the external opening of the Spiracular cleft (which see); (2) the blow-hole (nostril) of a whale.

Spiracular cleft, the front gill-cleft of some Fishes (*e.g.* Sharks), which is losing or beginning to lose its original function.

Spleen (the Greek name), a large abdominal ductless gland in Vertebrates, of doubtful function. It is richly provided with blood-vessels.

Splenic fever. See *Anthrax*.

Splint-bones, in the Horse, &c., the dwindled remains of 2nd and 4th metacarpals or metatarsals.

Spore (L. *spŏra*, seed), in some Animalcules, one of the minute parts into which the body breaks up during vegetative propagation of a particular kind.

Spore-formation, in some Animalcules, vegetative propagation by means of spores.

Sporocyst (Gk. *spŏra*, seed; *cystis*, a bladder), in Flukes, a shapeless bag-like stage in the life-history.

Sporoduct, in some Gregarines, one of the tubes by which the spores pass out of the firm case (cyst) in which they are produced.

Sporosac (Gk. *spŏra*, seed), in Zoophytes, a degenerate Gonophore (which see).

Staggers, in Sheep, a disease due to the presence of tape-worm cysts on the brain.

Stamen (Gk. *stēmōn*, a thread), a slender modified flower-leaf, which produces pollen.

Statoblast (Gk. *statŏs*, resting; *blastŏs*, a bud), in fresh-water Moss-Polypes, an internally formed winter-bud.

Sternal: (1) in Vertebrates, relating to the breast-bone or sternum; (2) in Arthropods, near the sternal or under side of the body.

Sternum, pl. **-a** (Gk. *stĕrnŏn*, the breast or breast-bone): (1) in Vertebrates, the breast-bone; (2) in Arthropods, that part of the exoskeleton covering the ventral surface of a segment.

Stigma, pl. **-ata** (Gk. for a mark): (1) the opening of an air-tube in Insects, &c.; (2) in Plants, the receptive surface to which pollen-grains adhere.

Stimulus, pl. **-i** (L. for an ox-goad), any physical or chemical agent by which a sense-organ is thrown into activity.

Sting, a piercing weapon that inflicts a poisoned wound. The name is not applied to parts connected with the mouth, such as the poison-fangs of a Viper.

Stipes (L. for a branch, or stump), in Insects, the second joint of the second jaw.

Stratified: (1) of epithelium, more than one cell thick; (2) of rocks, arranged in layers.

Stratum, pl. **-a** (L. for pavement), a layer of rock.

Struggle for existence, a metaphorical way of expressing the strenuous nature of Accommodation (which see).

Sturdy. See *Staggers*.

Subclavius, in Birds, the muscle which raises the wing.

Sublingual glands, a pair of salivary glands situated under the tongue.

Submaxillary glands, a pair of salivary glands situated between the halves of the lower jaw.

Submentum (L. *sub*, under; *mentum*, the chin), in Insects, the basal part of the lower lip.

Supination (L. *supinus*, lying on the back), position of forearm when palm of hand is directed upwards.

Supra-scapula, a skeletal element present above the scapula in some animals.

Sur-royal, the fourth branch of a Red Deer's antler (counting from its base).

Survival of the fittest. See *Natural selection*.

Swim-bladder, or **Air-bladder**, a gas-containing outgrowth from the digestive tube of some Fishes, which serves as a hydrostatic organ.

Symbiosis (Gk. *syn*, together; *biōsis*, life). See *Mutualism*.

Symmetry (the Greek name), regularity of build. In Radial Symmetry the parts of the body are arranged with reference to a centre of symmetry, *e.g.* in a coral polype. In Bilateral Symmetry, as seen, *e.g.*, in a Fish, we can distinguish right and left sides, anterior and posterior ends, upper and lower surfaces.

Sympathetic nervous system, a part of the nervous system concerned with the regulation of the blood-vessels and internal organs.

Syndactylous (Gk. *syn*, together; *daktylŏs*, a finger or toe), with some of the digits bound closely together.

Syrinx (Gk. for reed-pipe), the vocal organ or voice-box of a Bird, situated where the wind-pipe divides into a branch (*bronchus*) for each lung.

Systemic, applied to a heart which contains pure blood only.

Tail-coverts, feathers covering the tail-quills.

Tarsale, pl. **-ia**, one of the distal elements of the tarsus.

Tarso-metatarsus, a bone in the leg of a Bird, formed by the fusion of part of the ankle-skeleton (tarsus) with three of the instep-bones (metatarsus).

Tarsus (Gk. *tarsŏs*, the broadest part of the foot): (1) in Vertebrates, the skeleton of the ankle; (2) in Insects, the foot.

Teeth: (1) in Vertebrates, hard structures used for securing prey, or for breaking up food; ( ) hard projections with which the radula (which see) of Molluscs is studded; (3) small projections usually present in the "hinge" of a bivalve shell: they fit into corresponding sockets, and prevent shifting when the shell opens or closes.

Telson (Gk. for a termination), in higher Crustaceans, the last segment of the abdomen. It bears no limbs, and is the middle part of the tail-fin.

Tendon, a fibrous inelastic band by which a muscle is attached to a part of a skeleton.

Tensor muscles (L. *tendo*, *tentum*, *tensum*, to stretch), in Birds, muscles which keep the wing-membranes on the stretch.

Tentacle (L. *tento*, I feel), a soft feeler, *e.g.* one of the "horns" of a Snail, or one of the numerous fleshy filaments surrounding the mouth-end of a Sea-Anemone.

Tentaculocyst (tentacle; Gk. *cystis*, a bladder), in some Jelly-Fishes, a short specialized tentacle serving as a balancing organ.

Tergum, pl. **-a** (L. for the back), in Arthropods, that part of the exoskeleton covering the dorsal surface of a segment.

Test (L. *testa*, a shell), the firm investment of Ascidians, Echinoderms, and some other lower animals.

Tetradactyle (Gk. *tetra*, four; *daktylŏs*, a finger or toe), possessing four digits.

Thoracic duct, a narrow tube lying immediately ventral to the backbone. It receives most of the lymphatics, and opens into the great veins at the base of the neck.

Thread-cell. See *Nettling-cell*.

Thymus gland (Gk. *thymŏs*, the heart), a fatty-looking ductless gland situated (in Mammals) near the base of the heart.

Thyroid gland (Gk. *thyreŏs*, a shield; *eidŏs*, resemblance), a ductless gland in the neck-region, having something to do with regulating the nutrition of the body.

Tibia (the Latin name for (1)): (1) the shin-bone of Vertebrates; (2) that region of the leg in Insects, &c., which adjoins the foot.

Tibiale, in the tarsus, a proximal element situated on the side next the great toe.

Tibio-tarsus, in Birds, a bone formed by fusion of the shin-bone (tibia) with part of the ankle-skeleton (tarsus).

Tissue, an aggregate of cells specialized for the performance of some particular kind of physiological work.

Tornaria, pl. **-æ** (Gk. *tŏrnŏō*, I make round), the ciliated larva of some species of acorn-headed worm.

Tortoise-shell, an ornamental product prepared from the horny epidermic plates of certain Turtles.

Trachea (Gk. *trachēliaiŏs*, relating to the neck), the wind-pipe.

Tracheæ. See *Tracheal tubes*.

Tracheal gill, in some aquatic Insects, a gill traversed by air-tubes (*tracheæ*).

Tracheal tubes, the air-tubes of air-breathing Arthropods.

Tragus, a pointed projection ("earlet") within the ear of a true Bat.

Trepang, dried Sea-Cucumbers, an important article of food in the Far East.

Trez-tine. See *Antler-royal*.

Trichinosis, a disease due to the attacks of minute thread-worms (Trichinæ).

Trichocysts (Gk. *thrix*, *trichŏs*, a hair; *cystis*, a bladder), in some Animalcules, microscopic rods discharged from the outer layer of the body as a means of defence, and probably of irritant nature.

Tridactyle (Gk. *tri*, three; *daktylos*, a finger or toe), possessing three digits.

Triploblastic (Gk. *triplŏŏs*, threefold; *blastŏs*, a bud), applied to animals in which the body essentially consists of three cellular layers.

Trochanter (Gk. for a process of the thigh-bone), in Insects, the small second joint of the leg.

Trochosphere (Gk. *trŏchŏs*, a wheel; *sphaira*, a sphere), in various Invertebrates, a bilateral ovoid larva, with a well-marked head-lobe, at the base of which is a circlet of large cilia.

Tubercle, a rounded projection, *e.g.* on the crown of a tooth.

Tuberculated, possessing tubercles.

Tympanic (L. *tympanum*, a drum), connected with the drum of the ear in air-breathing Mammals.

Tympanum (L. *tympanum*, a drum): (1) the drum of the ear; (2) the cavity of the song-box (syrinx) of a bird.

Ulna (L. for the elbow), the bone of the fore-arm which is on the little finger side.

Ulnare, a proximal element of the carpus, situated on the side next the little finger.

Umbo (L. *umbo*, the boss of a shield), the projecting beak commonly possessed by each half of a bivalve shell, and which is the oldest part.

Uncinate (L. *uncinatus*, hooked), hook-like.

Unidactyle (L. *unus*, one; *daktylŏs*, a finger or toe), possessing one digit.

Univalve, applied to the shell of a Mollusc, when made up of only one piece or valve, as, *e.g.*, in a Snail.

Ureter, a tube by which the urine is carried off from a kidney.

Urostyle (Gk. *oura*, a tail; *stylŏs*, a pillar), the bony rod which forms the hinder part of a Frog's backbone.

Vacuole (L. dim. of *vacuum*, an empty space), in cells, a small space filled with liquid or gas. Pulsating vacuole, in Animalcules, a vacuole which alternately empties and fills in a regular manner.

Vagus nerves (L. *vagus*, wandering), the tenth pair of cranial nerves, which run back into the abdominal region.

Valve (L. *valva*, a folding-door): (1) an arrangement of one or more projecting flaps by means of which food in the gut, blood in the heart, &c., are obliged to move forward; (2) a distinct piece of shell. See *Bivalve and Univalve.*

Vane, the projecting flat part of a feather.

Variable aggressive coloration, in predaceous forms, coloration which changes with the surroundings so as to produce inconspicuousness.

Variation, the appearance of new characters with the result that no two individuals of the same species are exactly alike.

Vegetative propagation, increase by methods other than egg-production, *e.g.* by Gemmation, Fission, and Spore-formation (which see).

Vein, a blood-vessel which carries blood to or towards the heart.

Veliger (L. *velum*, a sail; *gero*, I carry), in Molluscs, a shell-bearing larva with a large ciliated head-flap by means of which swimming is effected.

Velum (L. for sail or veil), in some Jelly-fishes, an inwardly projecting shelf at the edge of the umbrella.

Ventral (L. for the belly), applied to the under side of an animal.

Ventricle (the Latin name), a relatively thick-walled and muscular heart-chamber, which pumps blood into arteries.

Vertebra, pl. **vertebræ** (the Latin name), one of the joints of the backbone.

Vertebral column, the backbone, or (in some Fishes) its gristly equivalent.

Vertebrate, applied to animals possessing a backbone or its equivalent.

Vestige, or **Rudimentary organ**, a structure which has undergone reduction, as the result of adaptation to surroundings.

Vestigial, reduced to a Vestige (which see).

Visceral, relating to the viscera. See *Viscus.*

Visceral arches and clefts, thickenings and slit-like openings on each side of the throat, which are possessed by every Vertebrate for at least part of its life. The clefts place the pharynx in communication with the exterior.

Visceral hump, the projecting upper part of many Molluscs, containing many of the chief internal organs.

Viscus, pl. **-era**, one of the internal organs contained in the chest or abdomen.

Vitelline membrane, the membrane surrounding an egg-cell.

Viviparous (L. *vivus*, alive; *pario*, I produce), giving birth to more or less well-developed young, as opposed to egg-laying.

Vocal chords, in Mammals, &c.; two elastic folds in the voice-box. A sound is emitted when their edges are brought parallel and thrown into vibration by an air-current.

Wallace's Line, the boundary between the Oriental and Australian regions.

Wampum, the shell-money and ornaments of North American Indians.

Warbles, swellings on the backs of cattle, caused by the presence of larval bot-flies.

Warning coloration, crude colours and patterns possessed by many inedible or well-armed forms, and producing conspicuousness. By advertising unpleasant properties it reduces the chance of attacks by enemies. Some forms are also protected by emitting warning sounds, or assuming warning (or terrifying) attitudes.

Water-vascular system, in Echinoderms, a system of tubes into which sea-water enters. It is concerned with locomotion and respiration.

White matter, that part of the central nervous system made up of nerve-fibres.

Wing coverts, feathers covering the wing-quills.

Zebra-mule, a cross between Zebra and Horse.

Zoæa, pl. **-æ** (Gk. *zōia*, life), in higher Crustaceans, a large-headed larva, swimming by its foot-jaws, and possessing a limbless abdomen.

Zoögeography (Gk. *zōŏn*, an animal), distribution of animals in space.

Zooid, in Moss-Polypes, one of the individuals of a colony.

Zoology (Gk. *zōŏn*, an animal), the science dealing with animals.

Zoophilous (Gk. *zōŏn*, an animal; *phileō*, I love), of flowers, pollinated by animals.

Zoophyte (Gk. *zōŏn*, an animal; *phyton*, a plant), a popular and rather vague word applied to various colonial lower animals, *e.g.* many Corals, which were at one time regarded as intermediate between plants and animals.

Zygodactylous (Gk. *zygŏn*, a yoke; *daktylŏs*, a toe), of the feet of some climbing Birds; with second and third toes turned to the front and first and fourth directed backwards.

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EXPLANATION OF PIGEON-MODEL

I.—External Appearance, showing Feathers, &c.

C, Cere. Cv, Wing Coverts. W, Wing Quills (*remiges*). T, Tail Quills (*rectrices*).

II.—Structure of Wing, Leg, &c.

ON WING: Cv, Wing Coverts. W, Wing Quills (*remiges*). B, Bastard Wing (*ala spuria*). Hu, Humerus. R, Radius. U, Ulna. H, Hand.

ON BODY: U.A., Upper Arm. F.A., Forearm. H, Hand. I, First Finger. Th, Thigh. Sh, Shin. Mt, Metatarsus. 1, 2, 3, 4, Toes. O, Oil-gland. Cl, Cloacal Opening.

III.—Skeleton

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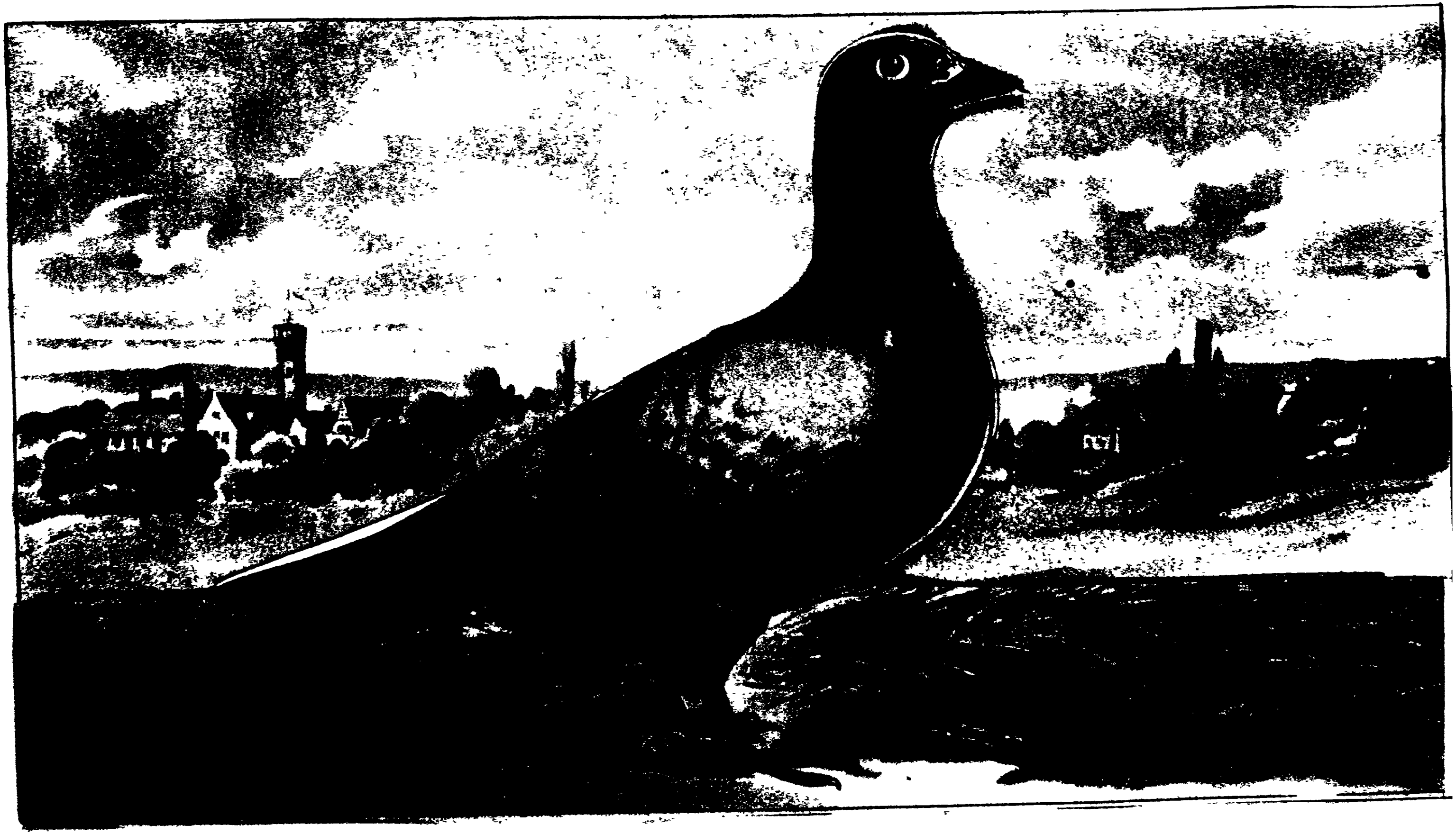

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